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16 SEP 83 AFGL-TR-83-0309 F19628-79-C-0103

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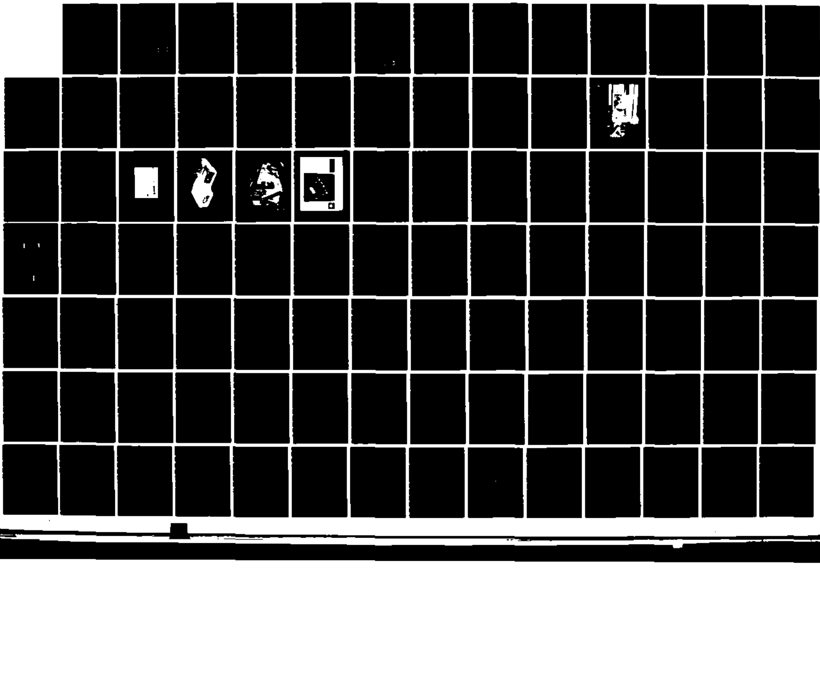

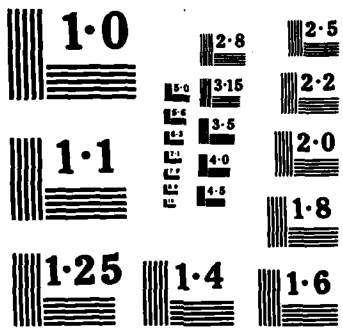

NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

(2)

AFGL-TR-83-0309

DESIGN OF SCIENTIFIC PAYLOADS AND COMPONENTS

Rudolph W. Ebacher
J. Mark Browne

Wentworth Institute of Technology
550 Huntington Ave.
Boston, Massachusetts 02115

Final Report
April 1979 - December 1982

16 September 1983

Approved for public release; distribution unlimited

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFB, MASSACHUSETTS 01731

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This technical report has been reviewed and is approved for publication

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Contract Manager

Edward F. McKenna

EDWARD F. McKENNA
Branch Chief

FOR THE COMMANDER

C. Nealon Stark

C. NEALON STARK
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20 ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Summarized in this report is the work performed under Contract F19628-79-C-0103, from April 1979 through December 1982. Efforts consisted of design and fabrication of one-of-a-kind payloads and instruments, field launch services, and refurbishment of recoverd payloads and instruments.

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TABLE OF CONTENTS

Numbers preceeding decimal point correspond with the project number.

1.0 INTRODUCTION

Summarized in this report is the work performed under Contract F19628-79-C-0103, from April 1979 through December 1982. Efforts consisted of design and fabrication of one-of-a-kind payloads and instruments, field launch services, and refurbishment of recovered payloads and instruments.

1.1 PROGRAM SUMMARY

Wentworth's primary task accomplished during contract F19628-79-C-0103 was to provide on-going applied research and engineering support directed toward the development of payloads for infrared measurements of space activity. Scientific and engineering results from successive experiments were used to analyze techniques and identify procedures for achieving new objectives. Selected procedures were sometimes bench tested in the laboratory with a simulated model to establish acceptability. Models in such instances lowered costs and established empirically the degree of success that could be expected.

The research and development of scientific payloads required familiarity with the broad range of environmental conditions encountered from ground level to 250 mile altitude levels. The range of pressures and temperatures necessitated that the application of techniques be exact to assure the proper articulation of electro-optical devices and other scientific sensors. Examples of factors which required expert knowledge were the identification of lubricants, material out-gassing characteristics, effect of disimilar metals in expansion and chemical stability. These factors were exceptionally critical on manned shuttle experiments where strict adherence to NASA specifications was necessary to assure safety.

Wentworth's skillful utilization of applied research techniques and engineering analyses resulted in high success ratings. Wentworth's numerous flight tested and qualified electronic/mechanical processes and componnents provided AFGL timely responses to payload assembly requirements. The overall program performance by Wentworth was excellent.

1.2

CHRONOLOGICAL LAUNCH SUMMARY

April 1979 to December 1982

	Launch Date	Project	Launch Site
1.	3 Aug. '79	A31.702 IR SPECTRA	WSMR
2.	14 Aug. '79	A08.706-2 IN-FLIGHT IGNITION	WSMR
3.	14 Aug. '79	A04.703 U.V. MEASUREMENTS	WSMR
4.	18 Aug. '80	A24.6S1-1 ZIP I	WSMR
5.	18 Sept. '80	A04.801 RECOVERY PACKAGE	PFRR
6.	Oct. '80	A10.901-1 IN-FLIGHT IGNITION	PFRR
7.	Oct. '80	A10.901-2 IN-FLIGHT IGNITION	PFRR
8.	16 Nov. '80	A13.073 IN-FLIGHT IGNITION	PFRR
9.	3 Feb. '81	A24.7S1-1 IRBS I	WSMR
10.	4 Feb. '81	A30.072 FWIF	PFRR
11.	6 Mar. '81	A10.903 AURORAL-E, DENSITY	PFRR
12.	31 July '81	A24.6S1-2 ZIP II	WSMR
13.	Nov. '81	A30.175 FWIF	PFRR
14.	23 Jan. '82	A24.7S2-2 FIRSSE	WSMR
15.	14 Sept. '82	A24.7S2-3 SPICE III	WSMR
16.	Nov. '82	A04.902	PFRR

SHUTTLE LAUNCHES:

27 June 1982 SETS-1 AFGL-8C4C, SHEATH, WAKE, & CHARGING
CRL-258 PENETRATING PARTICLES DETECTOR RE-ENTRY 4 JULY 1982

2.0 PROJECTS

An overview of Wentworth's thirty eight research projects is presented in this section.

2.1 A24.7S2-1 (SPICE I)

a. Configuration. The SPICE I payload is 38" in diameter and 190" long. The recovered weight is 1374 lbs. The payload was flown on a Aries rocket.

b. Task Elements. Contract personnel designed and fabricated mechanical and electrical systems to package the "Rockwell" experimental infrared telescope and its associated instruments. Integration activities and field support concluded with a unsuccessful launch on 27 January 1979.

c. Project Summary. The SPICE I sensor door unlatch mechanism failed in flight due to excessive loads on the door. This problem was caused by inadequate venting of entrapped air in the sensor cavity. There were no electrical or mechanical component failures and during flight all items performed within their designed values. The recovery sequence failed when the drogue to payload attach mechanism was overstressed and severed close to the payload. Specific procedures were initiated to prevent repetition of these problems.

2.2 A24.7S2-2 (FIRSSE)

a. Configuration. The FIRSSE payload is 38" in diameter and 86" long. The recovered weight is 1484 lbs. The payload was flown on a Aries rocket.

b. Task Elements. Contract personnel designed and fabricated mechanical and electrical systems to package the "Ball" experimental infrared telescope and its associated instruments. Appropriate qualification tests were performed. Integration activities and field support concluded with a successful launch on 23 January 1982.

c. Project Summary. The payload support system performance was good. All doors opened properly and on schedule; the IR sensor cap was removed and the sensor properly deployed, stepped, and subsequently stowed; and the doors were then closed in accordance with the intended sequence and timing. The recovery was successful.

2.3 A24.7S1-1 (IRBS I)

a. Configuration. The IRBS I payload is 38" in diameter and 91" long. The recovered weight is 900 lbs. The payload was flown on a Aries rocket.

b. Task Elements. Contract personnel designed and fabricated mechanical and electrical systems to package the "Honeywell" experimental infrared telescope and its associated instruments. Appropriate qualification tasks were performed. Integration activities and field support concluded with a unsuccessful launch on 27 January, 1980.

c. Project Summary. The IRBS I payload failed to separate from its Aries rocket. The payload and sensor were lost on this launch. No payload components were recovered due to the separation failure. Wentworth's responsibilities on this project did not include separation of the motor from the payload. Failure analysis investigations were performed by the organization responsible.

2.4 A24.7S1-2 (IRBS II)

a. Configuration. The IRBS II payload is a twin to IRBS I.

b. Task Elements. Contract personnel used prior drawings to fabricate some mechanical and electrical components.

c. Project Summary. When IRBS I failed this project came to a halt. The IRBS I sensor was supposed to be utilized on IRBS II.

2.5 RECOVERY

a. Configuration. Included under this project are the recovery of 15' diameter payloads which are developed by organizations other than Wentworth and are flown on Aerobee and Astrobee F rockets.

b. Task Requirements. Technical personnel are responsible for vehicle separation and parachute recovery of assigned payloads. Elements provided for under this task are the testing of the mechanical assembly and flight cables, and possible technical support on integration.

c. Summary. Responsibilities for program elements under this project were successful on all flights. Technical support on this critical program element was excellent. The following payloads were supplied with recovery packages:

A04.801	Launched July, 1980
A31.702	Launched August, 1979
A04.703	Launched August, 1979
A04.902	Launched November, 1982

2.6 BALLOON COMP.

a. Instrumentation Development and Fabrication.

Twenty units of a high frequency/frequency shift key data transmitters were delivered.

An AFGL prototype transition box assembly was completed.

Nineteen chassis plates were fabricated.

Ten 18 channel command selector assemblies were fabricated.

b. Summary. Assemblies were integrated into balloon experiments for AFGL.

2.7 A31.701

a. Project Summary. Planning and initial development for this project started under prior contract F19628-76-C-0211. This development stage of the payload ended by request of AFGL. At this time, several meetings and numerous interfaces with project personnel had resulted in design criteria for the payload. A preliminary time line had been established detailing payload functions. WIT electronics personnel had made initial studies into the needed components and a layout of the rack was determined. Spending on this project ceased in December 1979.

2.8 IN FLIGHT IGNITION

a. Configuration. This payload component was developed and designed for utilization in two stage rockets. The component ignited the second stage in flight. Actual weight of this component is 9 pounds 2 ounces. It was sized to fit in payloads of fifteen inches and less.

b. Task Requirements. Contract technical personnel developed, designed, and flight tested this system.

c. Project Summary. This system performed successfully on all rockets which utilized its function.

2.9 A31.702

a. Task Requirements. Technical personnel assembled and modified a split ejectable nose cone assembly. A recovery transition separation section and ballast plate were designed and fabricated for utilization on this payload.

b. Summary. The experiment on this payload was provided by Utah State University. Wentworth provided integration and mechanical support on its project elements. This Astrobee F rocket was

successfully launched in August 1979.

2.10 ZIP SENSOR

a. Configuration. The sensor consisted of numerous components and sub assemblies. The sensors outside dimensions were 22 inches in diameter by 41 inches long. A picutre of the ZIP Sensor and payload can be found in Section 4.10 of this report.

b. Task Requirements. Contract technical personnel developed, designed, fabricated and tested the ZIP Sensor.

c. Project Summary. The ZIP Sensor was designed for utilization on the ZIP payloads. It performed successfully on both ZIP payloads. AFGL's scientists are continuing to schedule the sensor for use on future experiments. The engineering development program provided to AFGL on this highly sophisticated cryogenics project was outstanding.

2.11 A24.6S1-1 (ZIP I)

a. Configuration. The ZIP I payload is 20 3/4" in diameter and 289" long. The recovered weight is 1300 lbs. The payload was flown on a Aries rocket.

b. Task Elements. Contract personnel designed and fabricated mechanical and electrical systems to package the ZIP infrared sensor and its associated instruments. Integration activities and field support concluded with a successful launch on 18 August 1980.

c. Project Summary. The payload support system performance was excellent. All doors opened properly and on schedule; the IR sensor cap was removed and the sensor properly deployed, stepped, and subsequently stowed, the sensor door closed in accordance with the intended sequence and timing. The door on the star mapper section can peeled open and the pins sheared upon re-entry. After investigations and analyses were concluded, it was decided that on future flights this door would require a latch to withstand wind shear pressures. A latch mechanism was subsequently designed, fabricated, and tested. This latch mechanism will be utilized for the first time on ELK I. The recovery of the ZIP I payload was successful.

2.12 A08.706-1

a. Project Summary. The IN FLIGHT IGNITION project was initially scheduled to fly on payload A08.706-1. Rescheduling moved the test flight of the IN FLIGHT IGNITION project to an alternate payload, (A08.706-2).

2.13 TACAN

a. Configuration. Two remote monitor component packages were

developed for TACAN. Their approximate dimensions are 9" in length, 2" in width, and 2" in height.

b. Project Summary. Contract personnel developed, designed, and fabricated two units. These units and their associated design prints were delivered to AFGL for testing and further development.

2.14 A30.072-1

a. Task Requirements & Summary. The payload experiment on this flight was the responsibility of Utah State University. Wentworth was responsible for the design and fabrication of support elements. These elements included; modification of a black brant nose cone, and fabrication of the separation, recovery and delta velocity can sections. In addition, integration activities and field support were provided to the project. On February 4, 1981, the rocket was launched from Poker Flats Research Range, Alaska. WIT's support functions were successful on this project.

2.15 A05.804-1

a. Project Summary. Technical contract personnel coordinated efforts to acquire 3 Black Brant Nose Cone assemblies from Bristol Aerospace. These nose cones were later structurally modified to meet design specifications on the following projects:

A30.072-1	Launched 24 April, 1980
A30.175	Launched November 1981
A30.276	To be determined

2.16 A24.7S2-3 (SPICE II)

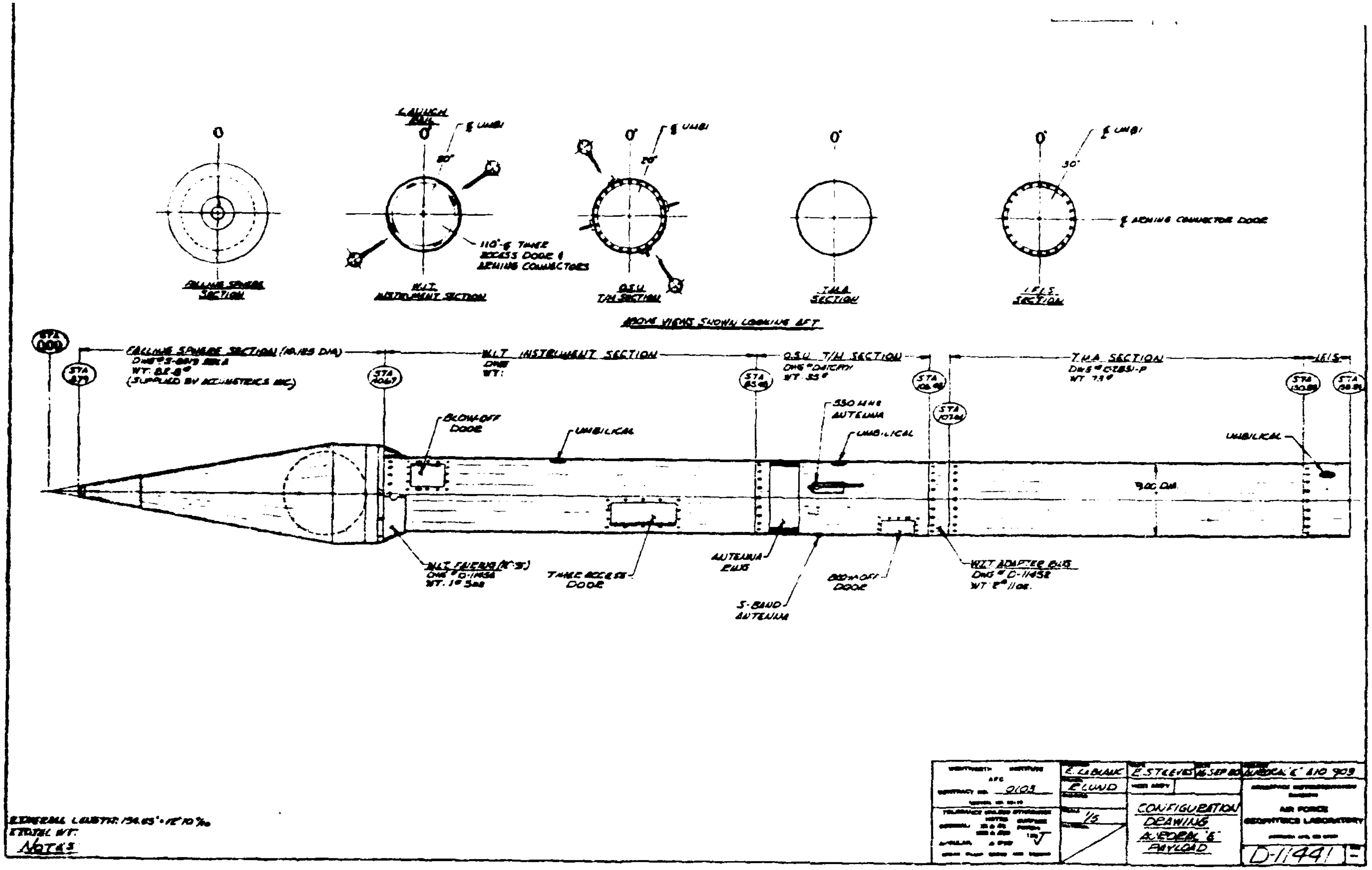
a. Configuration. SPICE II is virtually a twin to the SPICE I payload. The payload was flown on a Aries rocket.

b. Task Elements. Contract personnel designed and fabricated mechanical and electrical systems to package the Rockwell experimental infrared telescope and its associated instruments. Integration activities and field support concluded with a successful launch on 14 September, 1982.

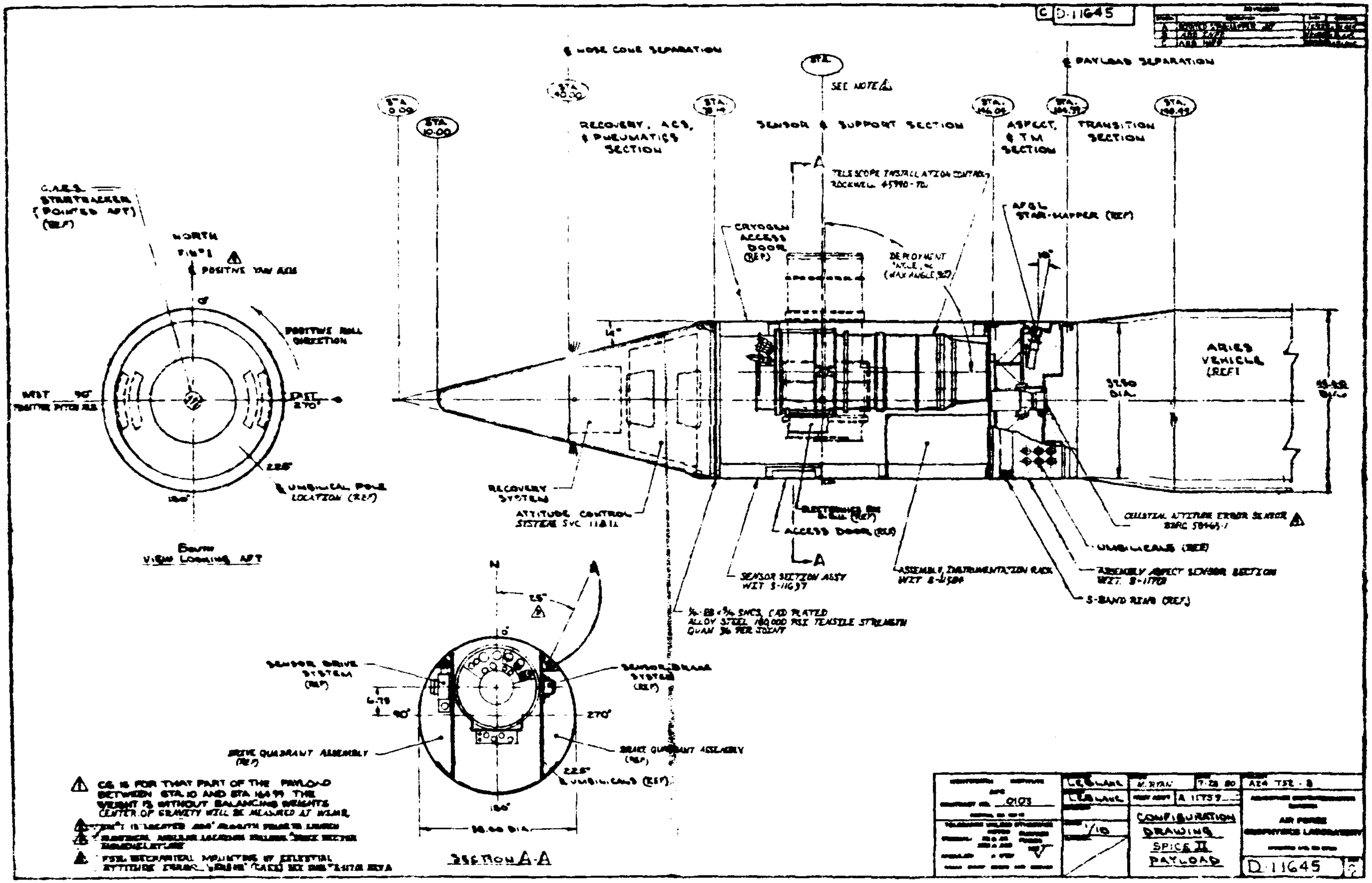
c. Project Summary. The payload support system performance was good. All doors opened properly and on schedule; the IR sensor cap was removed and the sensor properly deployed, stepped, and subsequently stowed; and the doors were then closed in accordance with the intended sequence and timing. The recovery was a success.

2.17 A08.706-2

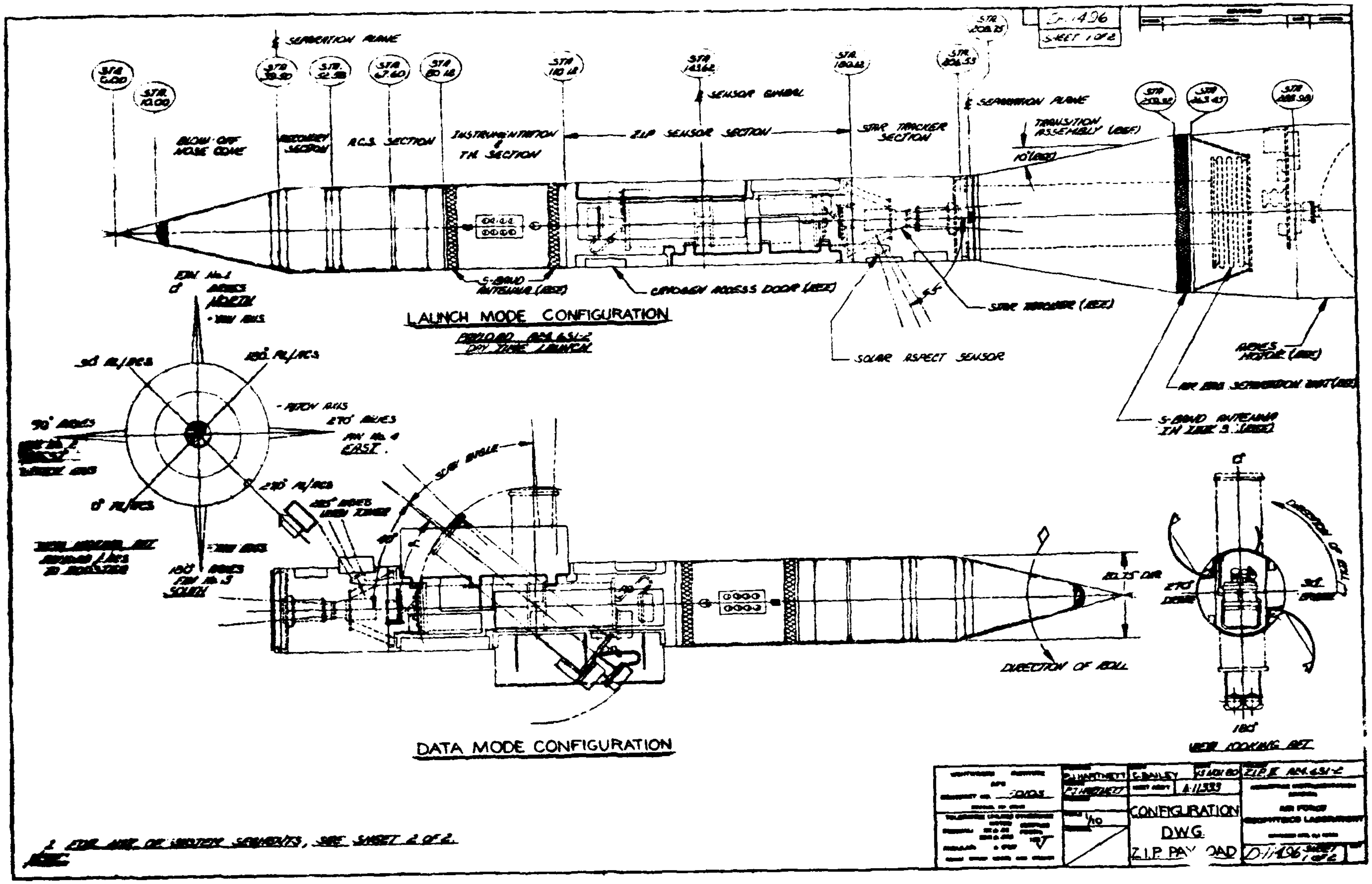
a. Configuration. A section can was fabricated for the packaging of



LAUNCH RAIL
FALLING SPHERE SECTION
W.I.T. INSTRUMENT SECTION
110°-℄ THREE ACCESS DOOR & ARMING CONNECTORS
O.S.U. T/H SECTION
T.M.A. SECTION
I.F.L.S. SECTION
℄ ARMING CONNECTOR DOOR
ABOVE VIEWS SHOWN LOOKING AFT
FALLING SPHERE SECTION (10.125 DIA)
(SUPPLIED BY ACCUMETRICS INC)
W.I.T. INSTRUMENT SECTION
O.S.U. T/H SECTION
T.M.A. SECTION
BLOW-OFF DOOR
UMBILICAL
330 MHZ ANTENNA
9.00 DIA.
W.I.T. FAIRING
THREE ACCESS DOOR
ANTENNA RING
S-BAND ANTENNA
W.I.T. ADAPTER RING
DWG # D-11452
EXTERNAL LENGTH: 154.65"
NOTES
CONFIGURATION DRAWING AURORA 'E' PAYLOAD
AIR FORCE GEOPHYSICS LABORATORY
D-11441



D-11645
NOSE CONE SEPARATION
PAYLOAD SEPARATION
SEE NOTE
RECOVERY, ACS, & PNEUMATICS SECTION
SENSOR & SUPPORT SECTION
ASPECT & TM SECTION
TRANSITION SECTION
TELESCOPE INSTALLATION CONTROL ROCKWELL 45990-70
AFGL STAR-MAPPER (REF)
CRYOGEN ACCESS DOOR (REF)
DEPLOYMENT ANGLE (MAX ANGLE)
ARIES VEHICLE (REF)
NORTH
POSITIVE YAW AXIS
POSITIVE ROLL DIRECTION
WEST 90°
EAST 270°
UMBILICAL POLE LOCATION (REF)
SOUTH
VIEW LOOKING AFT
RECOVERY SYSTEM
ATTITUDE CONTROL SYSTEM
ACCESS DOOR (REF)
SENSOR SECTION ASSY
ASSEMBLY INSTRUMENTATION RACK
CELESTIAL ATTITUDE ERROR SENSOR
UMBILICALS (REF)
ASSEMBLY ASPECT SENSOR SECTION
S-BAND RING (REF)
ALLOY STEEL 180,000 PSI TENSILE STRENGTH
SENSOR DRIVE SYSTEM (REF)
SENSOR BRAKE SYSTEM (REF)
DRIVE QUADRANT ASSEMBLY (REF)
BRAKE QUADRANT ASSEMBLY (REF)
UMBILICALS (REF)
CG IS FOR THAT PART OF THE PAYLOAD BETWEEN STA 10 AND STA 164.99 THE WEIGHT IS WITHOUT BALANCING WEIGHTS CENTER OF GRAVITY WILL BE MEASURED AT WSMR.
SECTION A-A
M. RYAN
CONFIGURATION DRAWING SPICE II PAYLOAD
AIR FORCE GEOPHYSICS LABORATORY
D-11645



LAUNCH MODE CONFIGURATION
PAYLOAD AM 651-2
DAY TIME LAUNCH
DATA MODE CONFIGURATION
BLOW-OFF NOSE CONE
RECOVERY SECTION
R.C.S. SECTION
INSTRUMENTATION & TM SECTION
Z.I.P SENSOR SECTION
STAR TRACKER SECTION
SEPARATION PLANE
SENSOR GIMBAL
TRANSITION ASSEMBLY (REF)
S-BAND ANTENNA (REF)
CRYOGEN ACCESS DOOR (REF)
STAR TRACKER (REF)
SOLAR ASPECT SENSOR
S-BAND ANTENNA TM LINK 3 (REF)
DIRECTION OF ROLL
VIEW LOOKING AFT
CONFIGURATION
DWG
Z.I.P PAY OAD
D-1496
SHEET 1 OF 2

4.10 ZIP Sensor and payload picture

4.0 Selected Project Diagrams

Contained in this section is a sampling of engine(-ing drawings and project pictures produced during contract F19628-79-C-0103.

3.4 PERMANENT STAFF

The permanent staff has developed unique expertise and competence in providing professional technical support to AFGL research and engineering projects. The twenty-two employees average eighteen years of experience exclusively on Wentworth Air Force R & D contracts. This intact and viable technology base ensures a continuity of support on long term efforts to advance infrared measurement systems.

Name	Title	Years at WIT on Research Contracts	Total Research Exp. - years	Education
Benassi, Howard	Spvr. Instrumentation	25	25	AS
Cabral, Rudolph	Instrument Maker	8	19	Cert.
Fritzler, Frederic	Alternate Supervisor	31	31	Cert.
Gambale, Alfonso	Instrument Maker	10	22.5	Cert.
Molter, Otto	Master Model Maker	18	19	Cert.
Ortendahl, Walter	Master Machinist	21	30	Cert.
Charron, Robert	Spvr. Electronics	24	24	AS
Campbell, Thomas	Electrical Engineer V	16	16	BS
Cutter, George	Alternate Supervisor	23	23	BS
Baratz, Milton	Elec Eng Technician IV	16	26	Cert.
DiMilla, Thomas	Elec Eng Technologist V	28	28	AS
LeBeau, Michael	Elec Eng Technician II	3	3	AS
Mundis, Paul	Elec Eng Technician V	18	35	AS
Nardella, Daniel	Elec Eng Technologist V	23	23	AS
Smart, Lawrence	Elec Eng Technician V	16	16	Cert.
Stromberg, Gustave	Elec Eng Technician V	18	30	AS
LeBlanc, Edgar	Spvr. Mechanical	32	32	Cert.
Cleveland, Frank	Mech. Techn. IV	31	31	Cert.
Hartnett, Paul	Alternate Supervisor	23	23	AS
Hurley, Patrick	Mech Eng Designer V	4	23	AS
Lund, Ray	Mech Eng Designer V	4 months	20	AS equiv.
Ebacher, Rudolph	Principal Investigator	4	35	MS
Browne, J. Mark	Asst. to Principal Investigator	1	1	BSET

3.2 FACULTY SUPPORT

Selected faculty members are utilized by the Principal Investigator in fields of their specialty. Faculty participation in research projects serves a dual purpose; it contributes needed expertise to the research program, as well as providing a unique opportunity for faculty enrichment. The following faculty provided support in the designated areas:

Douglas P. Locke - Administrative, (Technical Writing)
B.S., Physics, SUNY at Stony Brook.
Ph.D, Physics, University of Arizona.

Erwin M. Theodore - Manufacturing, (Machining)
B.S. Northeastern University, Boston.

George M. Morris - Manufacturing, (Numerical Control)
Wentworth Graduate.

John J. Kavolis, Jr. - Manufacturing, (Welding Processes)
A.S., Aeronautical Engineering, University of Illinois,
Welding Engineer, Allis Chalmers,
Certified A.W.S. Welding Inspector.

Donald Berkowitz - Mechanical Engineering (Design Analyses)
B.S., Mechanical Engineering, Northeastern University,
M.S., Mechanical Engineering, Northeastern University.

3.3 CO-OP STUDENT SUPPORT

The supervisors of the three organizational segments of the Air Force Contracts office utilize co-operative engineering students on research projects. This is not a new activity, WIT has been supporting enginering undergraduates as a part of research projects for many years. The co-operative students used have made significant contributions to the program. I believe the use of co-operative students is an excellent way to encourage undergraduates interest in DoD research objectives, as well as enhancing the possibility of them pursuing advanced engineering degrees. Both of these activities strengthen the country's technological base.

3.1 PROGRAM MANAGEMENT

The supervisors of the three organizational segments of the Air Force Contracts Office have a total of eighty-one years experience at Wentworth, and exclusively on Air Force R & D contracts. Mr. Edgar LeBlanc, with thirty-two years, has for many years taken Mechanical Engineering courses at Northeastern University and has an equivalent of four years of college training. As supervisor of Mechanical Design, he has been involved in the development of complex payloads.

Mr. Howard Benassi, Supervisor of Instrumentation Development, has kept abreast of Manufacturing Engineering technology developments. His expertise in the application of computer controlled machine tools, welding technology, non-destructive testing techniques and germane manufacturing processes provides assurance in the quality of payload elements and assemblies. He has twenty-five years experience at Wentworth on Air Force contracts.

Mr. Robert Charron, Supervisor of Electronics Engineering Design and Fabrication, has twenty-four years experience at Wentworth on Air Force R & D contracts. He has developed numerous electronic devices utilized in (in-flight) payload programming functions. He maintains current knowledge of rapidly changing electronic developments. He is presently enrolled in Wentworth's Baccalaureate Program in Computer Technology.

All three supervisors have had field launching experience of scientific payloads.

The Principal Investigator's education and experience background is as follows:

Principal Investigator: Rudolph W. Ebacher.

Education: B.S. in M.E. (Cum Laude), Univ. of New Hampshire, 1948; M.S. in Engineering, Univ. of New Mexico, 1952; Journeyman Toolmaker-completed 4 year apprenticeship as Machinist & Toolmaker, 1942-Watertown Arsenal.

Engineering Experience: 3 years at WIT; Consulting Engineer, 1978-1979; U.S. Dept. of Transportation, 1970-1978; Engineering Manager for major research projects; Retired from U.S. Government Service (34 years) 1978; NASA, Chief of Research Engineering, Electronics Research Center, 1965-1970; USAF Cambridge Research Laboratories, Chief of the Instrumentation and General Engineering Laboratory, 1960-1965; Watertown Arsenal, Chief of Manufacturing Engineering, 1955-1960; U.S. Naval Mission in Canada (Canadian Armed Forces) Chief Ordnance Engineer, 1952-1955; University of California (Los Alamos Scientific Laboratory) and for the U.S. Atomic Energy Commission, 1948-1952 (Design Engineer (Sandia Base); USNR Ship Repair (MMS1/C) Mediterranean; USAF-Lt.-R&D-Armed Forces Special (AFSWP) Weapons Project (Sandia Base); Registered Professional Engineer, Mass. #8614.

launched. The recovery was successful.

2.38 A31.200 SES-1

a. Task Elements and Summary. Contract personnel designed and fabricated a separation and recovery can, and a transition section. This rocket was successfully launched in March 1983.

can be mounted. LDEF is placed in an earth orbit by the Shuttle and can remain in orbit for extended periods of time.

A subsequent shuttle flight will retrieve LDEF and return it to earth so that the experiments can be removed and analyzed. Several experiments are being developed jointly by AFGL and NASA scientists which will include Wentworth's support. Wentworth has distinguished itself in this effort by being a contributor to the first experiment to integrate successfully on the LDEF structure. This experiment will investigate and determine the effects of exposure of materials and coatings by energized particles. The experiment will also attempt to identify and determine the energy levels of these particles.

b. Configuration A full scale picture of the LDEF structure and the CRL-258 experiment are presented in Section 4.35 of this report.

c. Task Elements and Project Summary. Contract personnel designed and fabricated the container housings which hold passive radiation detectors. Critical inspection and documented certification of all component parts, stock, and processes was done to conform with NASA specifications. Technical contract personnel coordinated efforts to have eighteen load housing assemblies and one proton plane assembly coated with special thermal control paint. The special paint was developed by Illinois Institute of Technology. It has superior resistance to heat and low to zero outgassing characteristics. Integration of the experiment onto LDEF was successfully completed. A LDEF flight is scheduled for the shuttle. Field support will be provided at this time.

2.36 HIGH STAR SOUTH II

a. Configuration. The HSS II payload is 15" in diameter and 161" long. The recovered weight has not yet been positively determined. The payload will be flown on a two stage caster lance rocket.

b. Task Elements. The payload casting was formerly utilized for the Hi Star program. The refurbishment of this payload required the design of a despin, instrumentation, and separation section. Also designed and fabricated were the mechanical and electrical systems needed to operate the experimental fair sensor and its associated instruments. The sensor was built by Hughes Aerospace but required modifications to fly in this payload. This payload is equipped with blow off doors and nose cone.

c. Project Summary. Work on this payload continues at Wentworth. Integration at AFGL and field trips will occur in 1983 or 1984.

2.37 A04.902

a. Task Elements and Summary. Contract personnel designed and fabricated a photometer can. This was done as part of the refurbishment of A04.703. In November, 1982, A04.902 was successfully

were fabricated to accomplish this requirement. Critical inspection and documented certification of all component parts, stock, and processes was done to conform with NASA specifications. Technical contract personnel coordinated efforts to acquire a multiple output voltage power converter from Analytyx Electronics Systems, Inc. This orbital experiment is scheduled for flight in the summer of 1983.

2.32 LAIRTS SENSOR

a. Task Elements and Project Summary. The design and fabrication of an experimental model vacuum vessel was accomplished. This model was used to test hypotheses concerning super-cooling capabilities. Two flight sensors are being developed with the capability to produce temperatures below 2° Kelvin for an extended period of time. Initial calculations concerning stresses, dewar capacity, etc., are being performed to arrive at an ultimate design.

Section 5.32 of this report includes some initial calculations which are helping to determine the design of these sensors. Development work is continuing on this project.

2.33 SCOOP Payload

a. Task Elements and Summary. This payload was given to AFGL by the Army. LTV Inc., designed and fabricated the payload. Studies are being made to determine whether AFGL can utilize this payload for an experiment. WIT contract personnel have designed and fabricated plugs to pressure test the instrument section. Discussions have determined that an alternative gimbal drive system is needed to deploy the sensor properly. Rough layouts were submitted to AFGL for considering these structural changes. The project is on hold until AFGL determines the best use for this payload. A modified "Hughes" sensor might be utilized on this project.

2.34 TPN-19 COMM IMP

a. Task Elements and Project Summary. Contract personnel designed and fabricated a prototype multiplex system for linking radar tower communications with ground sensors. Electronics Systems Division was extremely pleased with the successful performance of this unit and intends to acquire several units from industrial sources.

Section 4.34 of this report contains a picture of a completed unit.

2.35 SHUTTLE-LDEF

a. Description. The Long Duration Exposure Facility, (LDEF) was developed by NASA, Office of Aeronautics and Space Technology, to accommodate experiments which require a free flying exposure in space. LDEF is a structure on which many different experiments

ance. The rotation angle of the deployment mechanism was modified to step out 110°. Increased electrical requirements necessitated that more battery power be incorporated into the systems design. This payload has been fitted with a latch mechanism on the star mapper door. It is also the first payload to eliminate the use of a star tracker. Instead of this instrument an on board computer designed by Space Vector will perform the guidance function.

c. Project Summary. Integration activities are continuing at AFGL in preparation for a flight in 1983.

2.26 A30.276 BAFWIF

a. Task Requirements and Summary. The payload experiment on this flight was the responsibility of Utah State University. WIT provided maintenance support elements which included; (1) Modification of a Black Brant Nose Cone. (2) Test and preparation of the (separation, recovery and delta velocity) cans.

The payload was scheduled for launch during the spring of 1983.

2.27 PCM ENCODER

a. Description and Summary. Technical contract personnel designed, fabricated, and assembled electronic instrumentation for transmittal of flight data. This equipment is utilized on balloon-borne experimental payloads.

2.28 ELK Sensor

a. Task Elements and Summary. A limited amount of modifications were performed on the ZIP Sensor hardware to prepare the instrument for utilization in the ELK payload.

2.29 B.A.T. Boom

a. Task Elements and Summary. The Instrumentation Lab fabricated an extension boom mechanism. A picture of the completed job is displayed in section 4.29 of this report.

2.30 High Vac Pump

a. Task Elements and Summary. A High Vacuum Pump is being refitted, repaired, and requalified for use by WIT's mechanical technican. This pump will serve as a back up during field support on the High Star South II project.

2.31 DNA/SAT

a. Configuration. An intircate electron sensing probe approximately 7" in length by 1" in diameter was fabricated.

b. Task Elements and Summary. The electron sensing probe was linked to an arm which attached it to the satellite. Several small parts

in accordance with the intended sequence and timing. The recovery of the ZIP II payload was successful.

2.22 AURORAL E PROGRAM

a. Project Summary. In August 1980, technical contract personnel initiated the coordination of a subcontracting effort to acquire two Attitude Control Systems for AFGL. Space Vector Corporation, designed, developed, and tested the systems. The systems were incorporated into designated payloads.

2.23 ELIAS

a. Description and Summary. Initial development for this project started under prior contract F19628-76-C-0211. Contract personnel attempted to modify a tape casette drive system to utilize it as an in-flight recorder for sounding rocket payloads. This project developed into a request for WIT to design and fabricate a Rocket-borne Vibration Recorder, (ROVIR). The instrument which resulted has been utilized to obtain simulated in-flight and in-flight environmental data on Aries rockets. Expert eleectronic support was provided to calibrate the ROVIR instrumentation against control standards. In addition, technical support has been required on adjustments and various environmental system tests. During contract -0103, technical personnel modified and adjusted the ROVIR system to fly on the ELIAS payload.

2.24 Shuttle-Sets Pallet

a. Task Elements. Contract personnel designed and fabricated mechanical components and sensing probes for a passive exposure experiment performed for the space shuttle cargo bay. Thorough considerations into outgassing characteristics of materials and analyses of the systems design were done.

b. Project Summary. The Shuttle-Sets Pallet contained three probes which measured sheath wake and charging phenomenon. Two probes were 2" diameter E field probes and the third was an Electron probe. In addition, WIT designed and fabricated container elements for experiment (CRL-258) which passively measured the bombardment of MeV level particles. Wentworth's support on this engineering effort were highly successful. The developed expertise in working with NASA specifications aided in subsequent shuttle experiments which WIT participated in.

2.25 A24.6S1-3 ELK

a. Configuration. This payload was a refurbishment and modification to the previously successful ZIP 1 payload.

b. Task Elements. Contract personnel tested and re-equipped the payload components to prepare for another flight. The electronics maintenance section was improved by adding a redundant electrical system which increased the reliability of the payloads perform-

the IN FLIGHT IGNITION component. The section can is 9" in diameter by 5 5/8" long. This component can section was flown on a Nike Tomahawk rocket.

b. Task Elements. Contract personnel designed and fabricated this section can.

c. Project Summary. The IN FLIGHT IGNITION component flew piggyback to test its functional performance. The system performed successfully.

2.18 A30.175 BAFWIF

a. Task Requirements and Summary. Tasks on this project consisted of modifying an existing payload and preparing it for re-flight. A limited amount of design and fabrication was performed. WIT was also responsible for the recovery on this flight. This Aerobee rocket was successfully launched 14 August 1979.

2.20 A10.903 (AURORAL-E, DENS.)

a. Configuration. The (AURORAL-E, Density) payload is 9" in diameter and 158" long. The payload was flown on a Paiute Tomahawk rocket.

b. Task Elements. Contract personnel designed and fabricated electronic components and timers to perform payload maintenance tasks. The split nose cone assembly had been previously designed by WIT. The fabrication and functional support for the split nose cone was accomplished by utilizing Acumetrics Inc. The payload was designed for a Weitzman boom mechanism to deploy sensors beyond the skin. Integration activities and field support concluded with a successful launch on March 6, 1981.

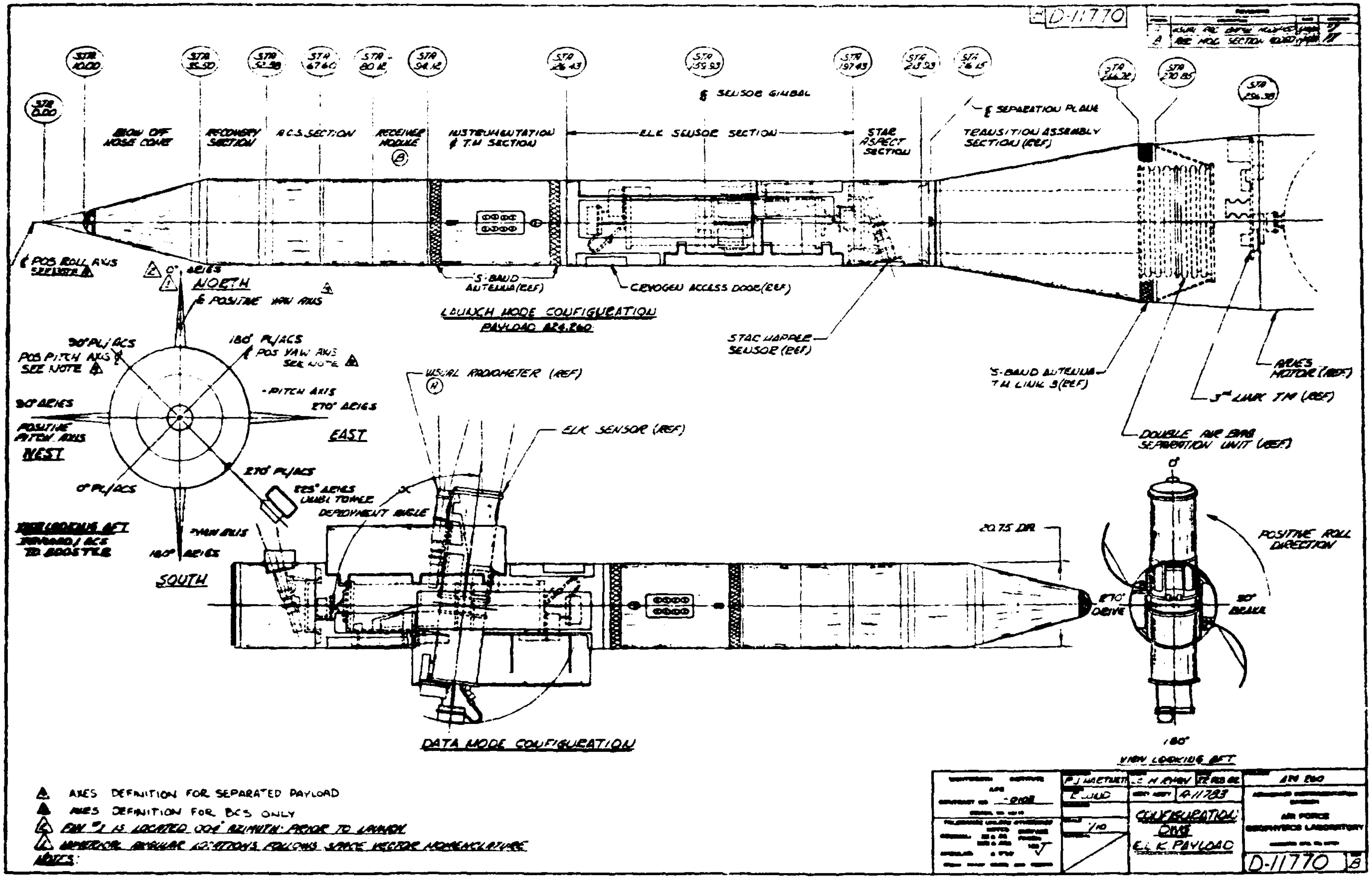
c. Project Summary. The payload support system performance was excellent. All components worked according to their programmed sequencing. There was no scheduled recovery for this experiment.

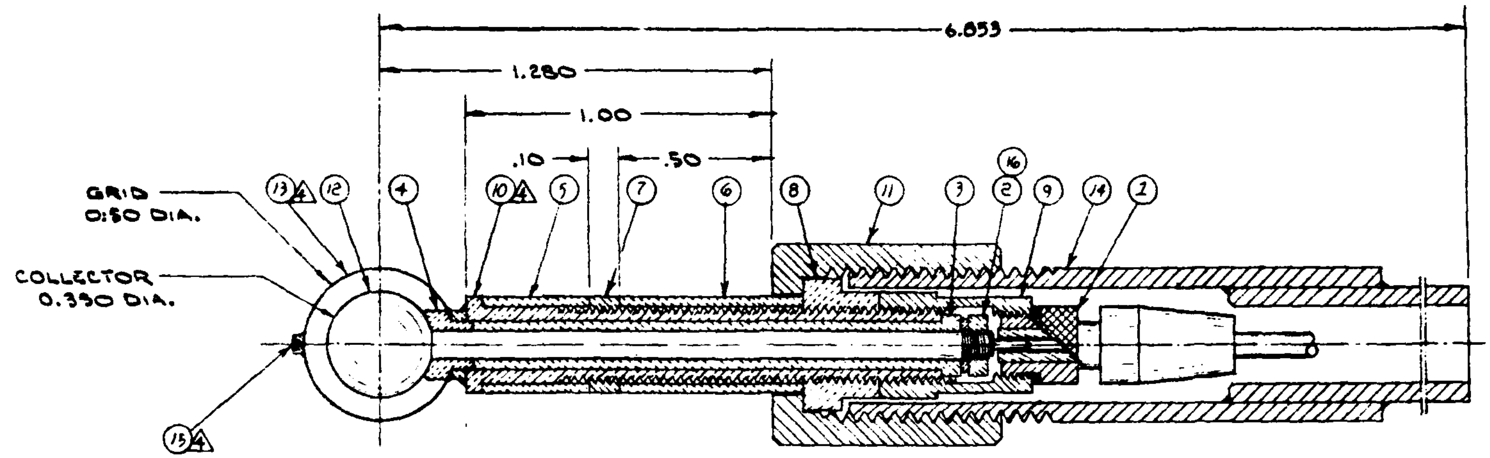
2.21 A24.6S1-2 (ZIP II)

a. Configuration. The payload diameter is 20 3/4" by 289" long. The recovered weight was 1300 lbs. The payload was flown on an Aries rocket.

b. Task Elements. Contract personnel designed and fabricated mechanical and electrical systems to package the ZIP infrared sensor and its associated instrumentation. The rotation angle of the deployment mechanism was modified to step out 90°. Integration activities and field support concluded with a successful launch on 21 July 1981.

c. Project Summary. The payload support system demonstrated repeated excellence in performance. All doors opened properly and on schedule; the IR sensor cap was removed and the sensor properly deployed, stepped, and subsequently stowed, the sensor door closed


D-1770
STA 0.00
STA 10.00
STA 35.50
STA 52.38
STA 67.60
STA 80.12
STA 94.12
STA 126.43
STA 155.53
STA 197.43
STA 213.53
STA 216.15
STA 270.85
STA 296.38
℄ SENSOR GIMBAL
℄ SEPARATION PLANE
BLOW OFF NOSE CONE
RECOVERY SECTION
A.C.S. SECTION
RECEIVER MODULE
INSTRUMENTATION & T.M. SECTION
ELK SENSOR SECTION
STAR ASPECT SECTION
TRANSITION ASSEMBLY SECTION (REF)
℄ POS ROLL AXIS SEE NOTE
'S'-BAND ANTENNA (REF)
CRYOGEN ACCESS DOOR (REF)
LAUNCH MODE CONFIGURATION
PAYLOAD A24.260
STAR MAPPER SENSOR (REF)
'S'-BAND ANTENNA T.M. LINK 3 (REF)
ARIES MOTOR (REF)
3rd LINK T.M. (REF)
DOUBLE AIR BAG SEPARATION UNIT (REF)
NORTH
℄ POSITIVE YAW AXIS
0° ARIES
180° PL/ACS
POS YAW AXIS SEE NOTE
90° PL/ACS
POS PITCH AXIS SEE NOTE
-PITCH AXIS
270° ARIES
90° ARIES
POSITIVE PITCH AXIS
WEST
EAST
0° PL/ACS
270° PL/ACS
225° ARIES UMBL TOWER DEPLOYMENT ANGLE
-YAW AXIS
180° ARIES
SOUTH
VIEW LOOKING AFT INBOARD ACS TO BOOSTER
VISUAL RADIOMETER (REF)
ELK SENSOR (REF)
20.75 DIA
POSITIVE ROLL DIRECTION
0°
270° DRIVE
90° BRAKE
180°
DATA MODE CONFIGURATION
VIEW LOOKING AFT
AXES DEFINITION FOR SEPARATED PAYLOAD
AXES DEFINITION FOR BCS ONLY
FIN #1 IS LOCATED 000° AZIMUTH PRIOR TO LAUNCH
NUMERICAL ANGULAR LOCATIONS FOLLOWS SPACE VECTOR NOMENCLATURE
NOTES:
CONFIGURATION DWG
ELK PAYLOAD
AIR FORCE GEOPHYSICS LABORATORY
A24.260
4-11783
D-11770
B



16	—	SPLIT LOCK WASHER #2	1	
15	C-11856	GRID RING	1	
14	C-11821	MOUNTING BOOM	1	
13	C-11819	ASSEMBLY GRID HALF	2	
12	B-11818	COLLECTOR	1	
11	B-11816	MOUNTING NUT	1	
10	A-11814	CONDUCTIVE BOLT	1	
9	A-11813	CONNECTOR MOUNTING RING	1	
8	A-11812	NUT (LOCKING)	1	
7	A-11811	GUARD RING	1	
6	A-11810-2	INSULATOR (GUARD RING)	1	
5	A-11810-1	INSULATOR (GUARD RING)	1	
4	A-11809	INSULATOR (SPHERE END)	1	
3	A-11808	INSULATOR (COLLECTOR STUD)	1	
2	A-11807	COLLECTOR STUD NUT	1	
1	B-11805	CONNECTOR ASSY. MICRODOT #031-0030-0000	1	
ITEM NO.	DWG NO.	DESCRIPTION	QTY	NOTE

4 SOLDER TWO GRID HALVES, ITEM NO. 13, AND THE GRID RING, ITEM NO. 15, TO THE CONDUCTIVE BOLT, ITEM NO 10, USING 60-40 SOLDER WITH ROSIN CORE.

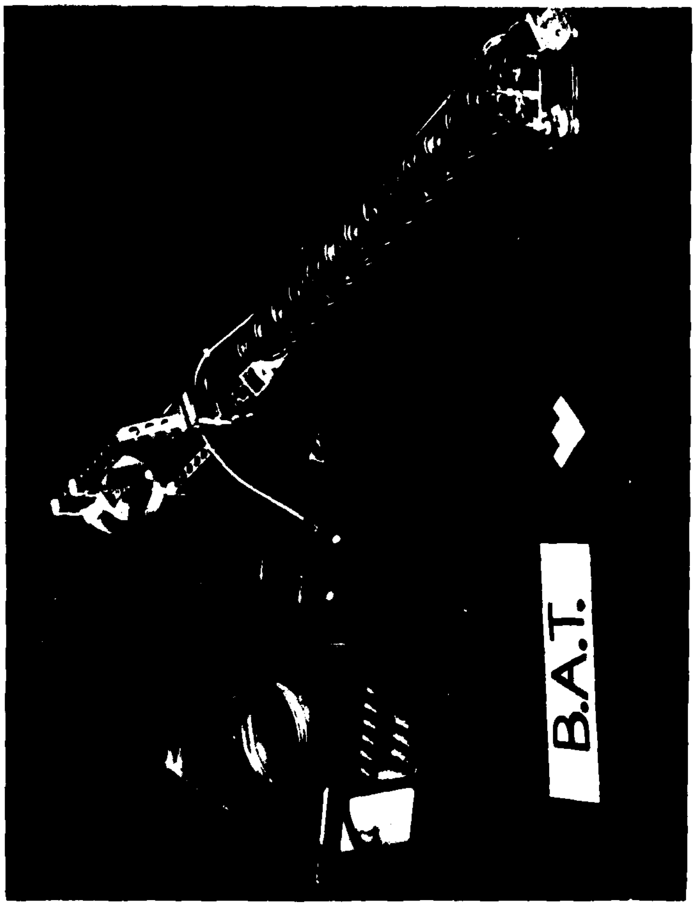
3 INSTALLATION PROCEDURE: PULL THE CONN. ASSY. (ITEM NO. 1) OUT BEYOND THE END OF BOOM AND SECURE WITH PLIERS. NEXT, MOUNT THE SENSOR ASSY. (WITH ITEM NO. 9 TORQUED) TO THE CONN. ASSY. BY ROTATING THE SENSOR AND TIGHTEN TO APPROX 25 IN. LBS. WITH PLIERS. NEXT, FEED THE EXCESS CABLE THRU BOOM UNTIL THE LEXAN NUT (ITEM NO. 8) SEATS ON END OF BOOM THEN TIGHTEN THE MOUNTING NUT (ITEM NO.) TO 20 IN LBS. KEEPING THE GRID BAND TO THE MOUNTING BASE.

2. ALL METAL PARTS EXCEPT MOUNTING BOOM, ITEM NO. 14, ARE FINISHED WITH GOLD PLATE, AND ASSEMBLY MUST BE HANDLED WITH PROTECTIVE GLOVES ONLY.

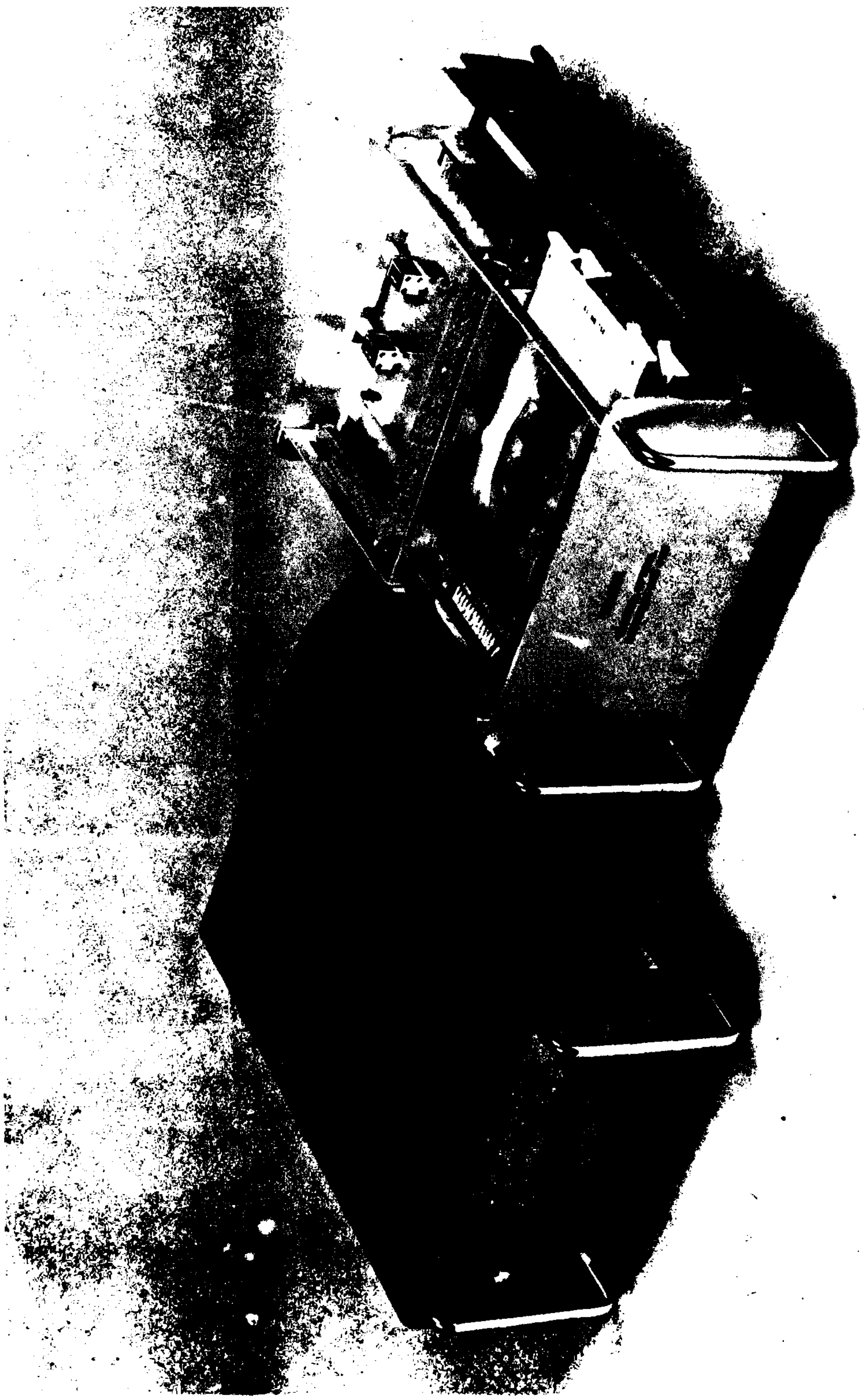
1. TORQUE SPECS ARE AS FOLLOWS, ITEM NO. 7-HAND TIGHT, ITEM NO. 8-HAND TIGHT, ITEM NO. 11-20 IN LBS, ITEM NO. 2-4 IN LBS., ITEM NO. 9-25 IN LBS., AND ITEM NO 1-25 IN LBS.

NOTES:

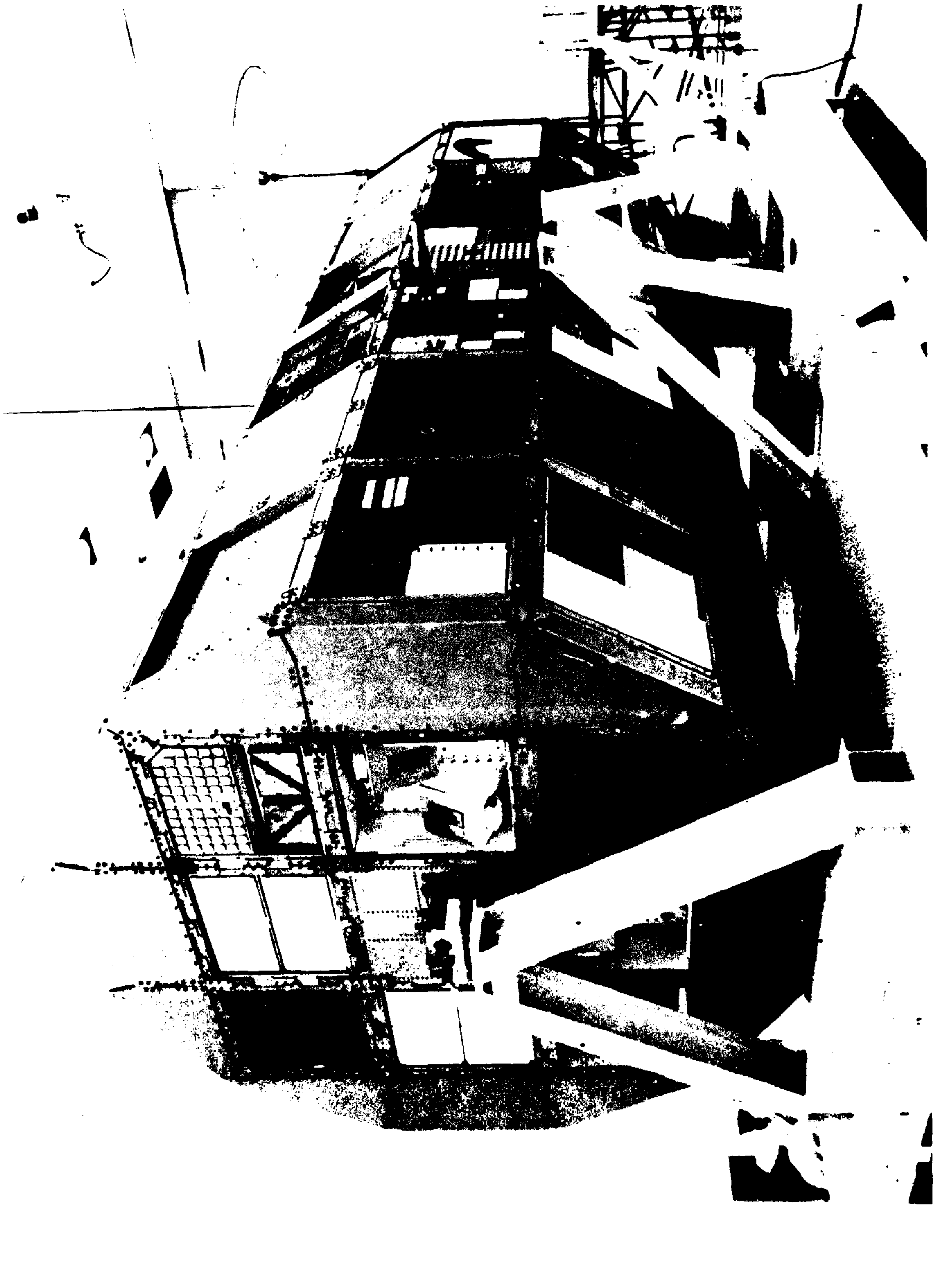
WENTWORTH INSTITUTE
AFC
CONTRACT NO. -0103
TOLERANCE UNLESS OTHERWISE NOTED
SCALE 4X
LEBLANC
R. JACOBS 3-26-82
DNA/BAT
DRIFTMETER/RPA EXPERIMENT - ELECTRON SENSOR
AEROSPACE INSTRUMENTATION DIVISION
AIR FORCE GEOPHYSICS LABORATORY
C-11803



4.29 B.A.T. Boom picture

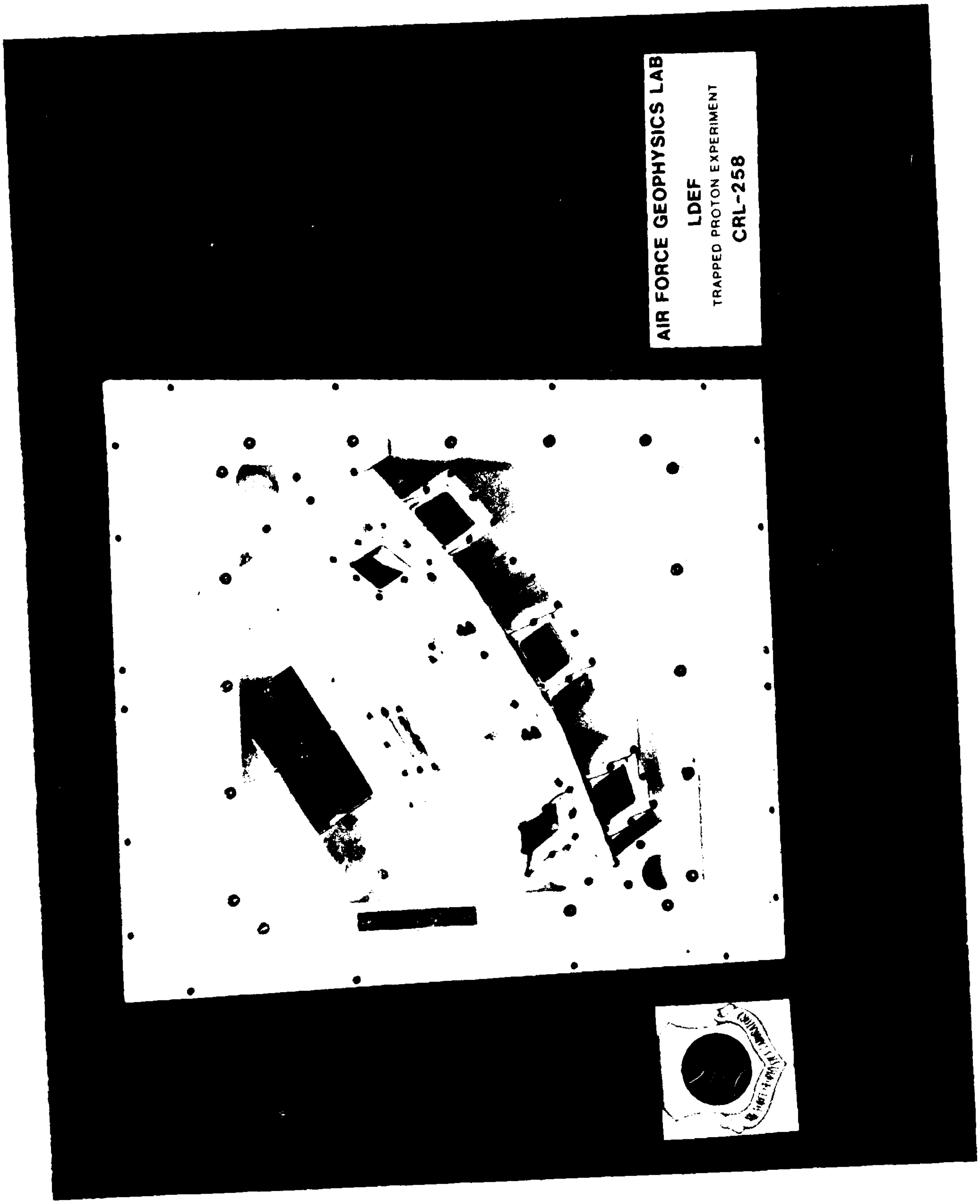


4.34 TPN-19 COMM IMP



NASA
L-84-1446

4.35 LDEF Structure Picture


AIR FORCE GEOPHYSICS LAB
LDEF
TRAPPED PROTON EXPERIMENT
CRL-258

5.0 SELECTED REPORT ANALYSES

Contained in this section is a sampling of engineering reports prepared for AFGL during Contract F19628-79-C-0103. Studies included, flight data reduction and analyses, instrument operation instructions, developmental design analyses, and structural design analyses.

The generations of payloads and sensors developed have become complicated and highly sophisticated systems. Analytical procedures have been initiated to improve on the successful performance of systems designs. In addition, work on shuttle projects has necessitated more critical inspection and documentation of parts, processes and designs. Some of these reports have been double sided to shorten the overall length of this final report.

A F C
DEPARTMENT
Wentworth
Institute of Technology

IN-FLIGHT IGNITION SYSTEM

OPERATING INSTRUCTION

JULY 1980

Prepared by: Robert W. Charron, Senior Electrical Engineer

I N F L I G H T I G N I T I O N S Y S T E M (I F I S)

TABLE OF CONTENTS:

In Flight Ignition System (IFIS) Operating Instructions

1.0 Bench Check:

1.1 Introduction:

This check is used to determine the operational status of the IFIS before installation. The test set-up uses the adapter box (Drawing #C-15174) which duplicates the cross-tying required at the launch pad terminal box.

1.2 Procedure:

1.2.1 Connect the various parts of the IFIS as shown in Figure 1. Install the Baro-switch Test Connector and the Arming Connector. Using Figure 2, check that the status of each item listed is as specified by column 1. (Do not at any time connect any EED's for this test.)

1.2.2 Plug into 115 VAC 60 Hz and turn on control box power using the key-operated switch at the lower left corner of the control panel. (See Figure 3.) Adjust control box power to 24-28 VDC using knob and voltmeter at left panel. Push ARM/DISARM toggle switch momentarily to the DISARM position. Check that panel matches the column 2 of the status chart.

1.2.3 Check that there is no change of status when the ARM/DISARM switch is held in the ARM position.

1.2.4 Turn the key-operated ARM ENABLE switch to "ON" and move adjacent toggle switch momentarily to the ARM position. The status should be as shown in column 3.

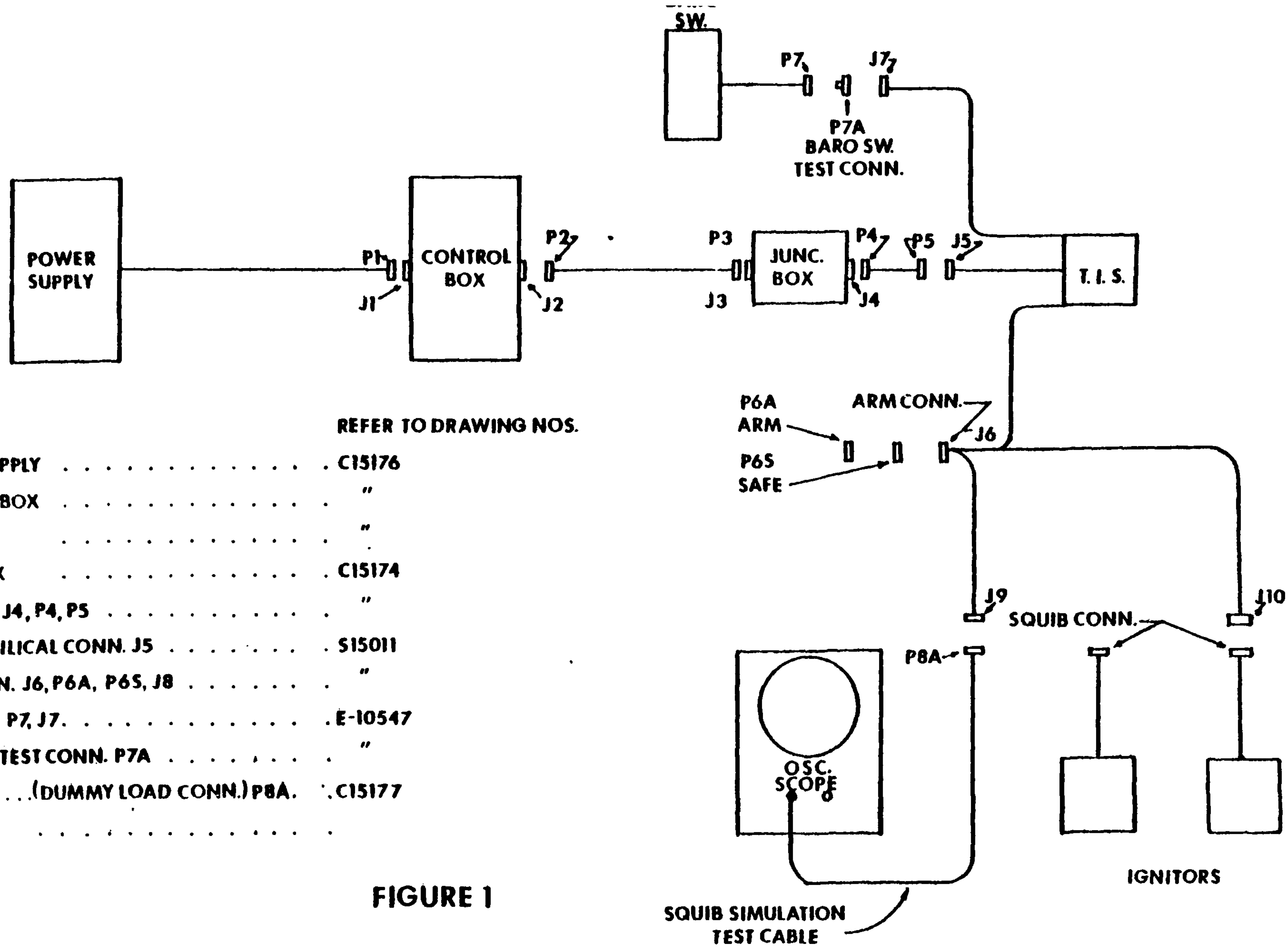
1.2.5 The CAP/BATT Voltmeters with their selector switches spring load to the CAP position will now show the storage capacitors charging up. Holding the selector switches to the BATT position allows one to check the voltage level of the battery packs in circuits #1 & #2.

1.2.6 Check that the capacitor bank charges up to the same voltage as the battery packs.

1.2.7 Using the key-operated switch labeled REMOTE START, start both timing circuits by turning it to ON. The status should now match those listed in column 4 of the Status Chart, Figure 2.

1.2.8 A timing device may be used to measure the period between starting the timing circuits and the capacitor discharge. (Discharge is evident when the capacitor voltage drops to approx. 0V.) When checking for proper circuit operation, a one ohm dummy load should be used and the output recorded for comparison with the data supplied with the unit. The Status Chart's column 5 represents this condition.

1.2.9 Terminating this test requires returning the REMOTE START switch to OFF, turning the ARM ENABLE switch OFF and disarming the system by moving the ARM/DISARM toggle switch to the DISARM position. The control panel reverts to the status of column 2.



NOTE:	REFER TO DRAWING NOS.
POWER SUPPLY	C15176
CONTROL BOX	"
P1, J1, J2	"
JUNC. BOX	C15174
P2, P3, J3, J4, P4, P5	"
T.I.S., UMBILICAL CONN. J5	S15011
ARM CONN. J6, P6A, P6S, J8	"
BARO SW. P7, J7.	E-10547
BARO SW. TEST CONN. P7A	"
S. S. T. C. . . . .(DUMMY LOAD CONN.) P8A.	C15177
IGNITOR	

FIGURE 1

BENCH CHECK STATUS CHART

ITEM	STATUS #1	#2	#3	#4	#5
Control Box Pwr. Key Sw.	OFF	ON	ON	ON	ON
Control Box Pwr. Mon.	OFF	ON	ON	ON	ON
Control Box Pwr. Voltmeter	OV	24-28V	24-28V	24-28V	24-28V
ARM ENABLE Key Sw.	OFF	OFF	ON	ON	ON
ARM/DISARM Toggle Sw.	OFF	DISARM	ARM	OFF	OFF
ARMED Mon. Ckt. #1	OFF	OFF	ON	ON	ON
ARMED Mon. Ckt. #2	OFF	OFF	ON	ON	ON
DISARMED Mon. Ckt. #1	OFF	ON	OFF	OFF	OFF
DISARMED Mon. Ckt. #2	OFF	ON	OFF	OFF	OFF
START Mon. Ckt. #1	OFF	OFF	OFF	ON	ON
START Mon. Ckt. #2	OFF	OFF	OFF	ON	ON
RESET Mon. Ckt. #1	OFF	ON	ON	OFF	OFF
RESET Mon. Ckt. #2	OFF	ON	ON	OFF	OFF
RUN Mon. Ckt. #1	OFF	OFF	ON	FLASHING	FLASHING
RUN Mon. Ckt. #2	OFF	OFF	ON	FLASHING	FLASHING
CAP/BATT. VOLTMETER Ckt. #1	OV	OV	0→26V	26V	26→OV
CAP/BATT. VOLTMETER Ckt. #2	OV	OV	0→26V	26V	26→OV
CAP/BATT Toggle Sw. Ckt. #1	TO CAP	TO CAP	TO CAP	TO CAP	TO CAP
CAP/BATT Toggle Sw. Ckt. #2	TO CAP	TO CAP	TO CAP	TO CAP	TO CAP
Baro Switch Connector	Installed	Installed	Installed	Installed	Installed
Arming Connector	Installed	Installed	Installed	Installed	Installed
REMOTE START Key Switch	OFF	OFF	OFF	ON	ON

F I G U R E 2

during which the IFIS should be left in the "ARMED" state. Upon declaration of status change to "Misfire", the IFIS may be disarmed.

4.0 Countdown/Launch Instructions:

4.1 Introduction:

The only prerequisite that exists for a successful 2nd stage ignition is to have the IFIS armed prior to lift-off. The capacitors will charge up before the ignition time-out occurs, even when started just prior to lift-off. In general that arrangement does not represent best practice as it doesn't allow enough time to measure battery and capacitor voltage levels. The following instructions need not be used with the time values shown, however, it should be remembered that the system is most vulnerable in the ARMED state.

4.2 Countdown:

4.2.1 T-30 minutes - Turn ON Control Box power, check voltage level. Using Figure 2, all items should match the status shown in column #2.

4.2.2 T-5 minutes - Turn the ARM ENABLE key switch to ON and move toggle switch to ARM position. Monitor the charging character of the capacitors. Record their voltage levels along with the batteries voltage.

4.2.3 T-4 minutes - Check control panel's status with Figure 2's, Column #3. If everything checks O.K., the IFIS is ARMED and Flight-Ready.

4.3 Hangfire/Misfire:

4.3.1 "Hangfire" is the condition where an ignition pulse was received by the first stage ignition but it didn't fire. The "Hangfire" status could exist for some length of time

IFIS ARMING PROCEDURE / CHECKLIST DATE:---------------------

FUNCTION	CHECKED BY	DATE
E. Check battery voltage levels, record. Ckt. #1______________VDC. CKT. #2______________VDC.		
F. Return ARM/ENABLE Switch to OFF and "Disarm" the IFIS.		
G. Check that capacitors show normal discharge characteristics.		
H. Turn Control Box power OFF.		
I. Remove keys (and unplug 115 VAC if desired).		
J. IFIS is Flight-Ready.		

IFIS ARMING PROCEDURE / CHECKOUT LIST DATE:----------------

FUNCTION	CHECKED BY	DATE
3.7 Final Arming		
A. Perform visual check for proper rigging of Umbilical Cable etc.		
B. Check that control panel matches the Status Chart's column #1.		
C. Remove SAFE (P6S) plug and install ARMING Connector P6A.		
D. Secure with proper hardware.		
E. Install access door.		
3.8 Blockhouse Check		
A. Clear launch area of all personnel.		
B. Turn Control Box power ON.		
C. Turn ARM/ENABLE Switch ON and push toggle switch to ARM position.		
D. Check that capacitors charge up in a normal fashion, record the voltage levels. Ckt. #1 ______________ VDC Ckt. #2 ______________ VDC		

FUNCTION	CHECKED BY	DATE
3.6 Ignitor Squib Check.		
A. Check that control panel power is OFF and that panel matches the Status Chart's column #1.		
B. Remove SAFE Connector.		
C. Using an Alinco Squib Testor (or equivalent), balance out the test leads then connect to pins #4 & #8 of J6.		
D. Measure squib bridge resistance and record. ____________________ohms.		
E. Change to pins #4 & #7 and measure second bridge resistance. ____________________ohms.		
F. Check that values measured, match those measured earlier at the Ignitor's Squib Connector.		
G. Check that values measured fall within manufacturer's specifications.		
H. Replace SAFE Connector.		

FUNCTION	CHECKED BY	DATE

3.5 Static Discharge Check

A. Switch IFIS to the "Disarmed" status.

B. Install the P6S SAFE Connector.

C. Using the VOM with batteries installed (ONLY WHEN P6S IS INSTALLED). Set scale to measure 100K ohms static discharge resistor.

D. A Winchester 2 pin connector exposes two test points on the back of the SAFE Connector. Connect the VOM to one pin and chassis ground. Record resistance.

______________________ohms.

E. Connect VOM to second pin and record resistance to chassis ground.

_____________________ohms.

F. Switch IFIS to the "Arm" status and repeat steps D & E.

D__________________ohms.

E__________________ohms.

G. Switch IFIS to the "Disarm" status, and turn control panel power "OFF".

IFIS ARMING PROCEDURE / CHECKOUT LIST   DATE:--------------

FUNCTION	CHECKED BY	DATE
I. Repeat Steps E & F. ________________DC ________________AC		

3.4 Continuity Check

A. Switch IFIS to the "Disarmed" status.

B. Balance out the lead resistance of the Alinco Tester (or equivalent squib bridge resistance measuring device).

C. Connect to pins #1 & #6.

D. Measure for < 0.5 ohms.
Record reading____________ohms

E. Switch IFIS to "Armed" status and record reading_____________ohms.

F. Switch IFIS back to "Disarmed" and change test leads to pins #5 & #9.

G. Repeat step D. Record readings.
________________ohms.

H. Switch IFIS to "armed", record readings ________________ohms.

IFIS ARMING PROCEDURE / CHECKOUT LIST DATE:---------------

FUNCTION	Checked by	Date
3.3 No voltage check.		
A. Verify with the blockhouse that the IFIS Control Panel status is as specified in Column #2 of the Bench Check Status Chart (Figure 2).		
B. Check that batteries have been removed from VOM.		
C. Connect VOM to pins #1 & #6 of the Arming Connector, J6.		
D. Check for presence of AC and DC Voltage. Record readings: _______________ DC _______________ AC		
E. Request that IFIS be switched to the "Armed" status. Verify that control panel matched column #3.		
F. Repeat step D. Record readings: _______________ DC _______________ AC		
G. Switch unit to "Disarmed" status and change test leads to pins #5 & #9.		
H. Repeat Step D. _______________ DC _______________ AC		

3.2 Equipment:

The following items are required for the checks:

1. A VOM (with batteries removed).
2. An ALINCO Model #101-5CFG Squib Tester or equivalent.
3. A proper* set of test leads.
4. P6S, SAFE plug and P6A, Arming plug. See IFIS Drawing #S15011.
5. IFIS Arming Procedures and checkout list.

* The test leads must be fitted with pins that match the Output and Arming connectors.

3.0 IFIS Arming:

3.1 Introduction:

The IFIS arming at the launch pad is accomplished by performing four distinct tests and then installing the Arming Connector. These tests are:

#1 A No-Voltage Check - used to check for the presence of voltage at the IFIS Output Connector.

#2 A Continuity Check, to determine whether the IFIS circuitry maintains a short circuit on the Ignitor's squib inputs.

#3 The Static Discharge Check, used to check for the presence of the 100K ohm static discharge resistor.

#4 Ignitor Squib Check, a final measurement of the Ignitor's Squib bridges.

These checks are used to ensure the safe arming of the rocket motor and are performed prior to connecting the ignitor to the IFIS. Performing them requires that the individuals performing the test be in communication from launch pad to the blockhouse. Tests #1, #2 & #3 are made in both the Armed & Disarmed condition which requires switching the IFIS from the blockhouse.

B. A proper set of test pins.

3. Procedure:

A. Remove any shorting device from the ignitor's connector. (P4 on Thiakol's drawing #D-5247)

B. Balance out the test lead resistance and connect to pins #4 & #7 of the connector. Measure (and record) the bridge resistance.

C. Repeat step "B" using pins #4 & #8.

4. Results:

The values measured should fall within the manufacturer's specifications.

2.2.8 Fresh batteries for flight should be installed if those used during this test have been used extensively. Each flight battery's voltage should be checked and entered below:

Circuit #1	Batt. #1 ______	V.
	Batt. #2 ______	V.
	Batt. #3 ______	V.
Circuit #2	Batt. #1 ______	V.
	Batt. #2 ______	V.
	Batt. #3 ______	V.

Date: ______

By: ______

B. A set of *proper test leads.

3. Procedure:

A. Connect the VOM to the Output Connector (Figure 1, J8), pins #4 & #7.

B. Check for voltage, starting on high range and switching to low, with the IFIS in the disarmed and armed condition.

C. Check for continuity between pins.

D. Remove test lead from either pin and ground it to the chassis. Measure 100K ohm static discharge path from chassis to either pin.

E. Connect VOM to pins #4 & #8 and repeat B, C & D.

4. Results:

There should be no signs of voltage at either pair of pins. Each pair should exhibit a short circuit and 100K ohms to chassis ground.

2.2.5 Remove the Baro-switch Test connector. (The Test connector shorts out the Baro-switch contacts for test purposes. These contacts remain open at ground level.) Install the Flight connector, P7. (The Flight connector removes the short across the open Baro-switch contacts.)

2.2.6 Check that the Control Panel is turned off and complies with the status of column 1, of Figure 2 before continuing.

2.2.7 Perform the next check before mounting the extension to the Tomahawk rocket motor while the ignitor's connector is readily accessible.

1. Purpose:

To measure and record the resistance value of the ignitor bridges.

2. Equipment:

A. Alinco Model 101 5CFG Tester or equivalent.

*These leads must be fitted with pins that mate correctly with the connector being tested.

2.0 Installation/Operational Check:

2.1 Introduction:

Upon satisfactory completion of the bench checks, the IFIS is ready for installation. The following instructions relate to the electrical installation of the IFIS as it's packaged in an extension, fitted to the rocket motor.

2.2 Procedure:

2.2.1 Mount the components listed, inside the extension (if not already mounted).

1. Electronics package.
2. Baro-switch Plenum (use special tubular screws, see drawing #D-1129c).
3. Umbilical Connector.
4. Arming Connector.
5. Output Connector.

2.2.2 Connect the system together as was done during the Bench Check.

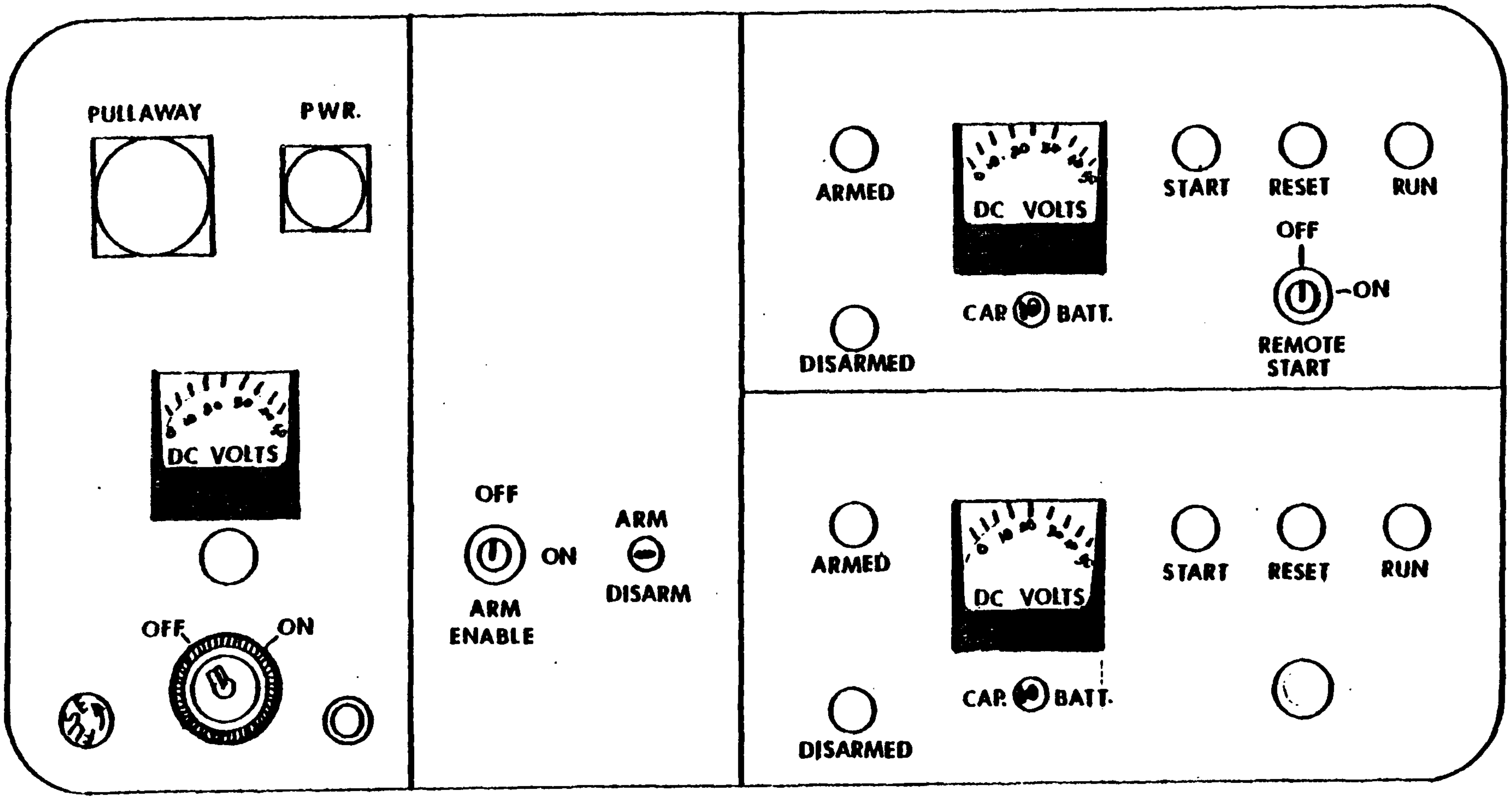
2.2.3 Turn Control Box power to ON. Check panel status. (It should match Figure #2, Column #2.)

2.2.4 Install the arming connector's "SAFE" plug, (Figure 1, P6S), then perform the next test.

1. Purpose:

   To determine if the "SAFE" plug when installed in the "ARMING" connector, maintains a short circuit on the ignitor bridges, provides a 100K ohm static discharge path to chassis ground and isolates the bridges from the output voltage when the IFIS is armed or disarmed.
2. Equipment:

   A. One VOM.



(I.F.I.S.) CONTROL PANEL

FIGURE.3

5.0 Battery Checker Instructions:

5.1 Introduction:

This Battery Checker has one purpose, to determine whether a battery being tested is suitable for use in the TIS. It does not tell whether a battery is good or bad, only whether it's acceptable or not.

5.2 Procedure:

5.2.1 Plug tester into 115 VAC 60Hz.

5.2.2 Remove battery plug from test unit.

5.2.3 Connect battery to terminals.

5.2.4 Insert battery plug into test unit.*

5.2.5 Turn power switch on.

5.2.6 Set selector switch for type of battery being tested, either alkaline or carbon/zinc.

5.2.7 Monitor battery voltage during test period.

5.2.8 Press "START" button. Monitor lamps will be off during the test period. When the test is finished, the "TEST COMPLETE" monitor goes on along with either the "YES" or "NO" monitor lamp, thus indicating acceptance or rejection of the battery.

NOTE* If battery voltage is reversed, the internal fuse will blow. Refer to Drawing No. S-15178.

6.0 IFIS DRAWING LIST

6.1 E-10547 Tomahawk Ignition Section.

6.1.1 A10550 Conn. Brkt.

6.1.2 A10555 Conn. Brkt.

6.1.3 B10556 Cover Ignition Section

6.1.4 C4909 Brkt. Pullaway

6.1.5 E11302 Housing T.I.

6.2 D11296 Pressure Differential Assembly

6.2.1 A11300 Screw Reworked

6.2.2 A11301 Bracket Tie-Down

6.2.3 B11299 Gasket

6.2.4 B11309 Mounting Bracket

6.2.5 C11298 Mounting Plate

6.3 D11313 Electronics Box

6.3.1 A11341 Insulator P.C. Board

6.3.2 A11342 Insulator Battery Tray

6.3.3 A11343 Insulator Side

6.3.4 A11344 Insulator Cover

6.3.5	A11345	Insulator Battery Separator
6.3.6	B11325	Cover Top
6.3.7	B11326	Cover Side
6.3.8	B11328	Base Plate
6.3.9	C11323	Battery Tray
6.3.10	C11327	Side Plate
6.4	S15011	Electrical Schematic
6.4.1	C15175	Component Placement
6.4.2	C15177	Squib Simulator Test Cable
6.5	C15174	Pullaway, Junction Box
6.6	D15176	Control Box
6.7	S15178	Battery Checker

In-Flight Ignition System

This system is contained in three major packages; they are -- the flight unit, the control box and the battery test instrument. The flight unit consists of a tubular payload extension, some five or six inches long, with tensile joint provisions at each end. It houses the system's flight electronics, baro plenum, the pullaway, output and arming connectors and the associated cabling. The control box is a fiberglass case with a power supply mounted in one half and a control panel in the other. The battery test circuitry is housed in a standard instrument case. It is used to determine the fitness of the batteries used in the flight unit.

WENTWORTH INSTITUTE OF TECHNOLOGY

AIR FORCE CONTRACTS DEPARTMENT

SPICE 2 (A24.7S2-3)

END OF FLIGHT REPORT

Author: Tom DiMilla,
Electronics Technologist

Date: December 29, 1982

SPICE-2 (A24.782-3)

E.O.F. Report

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Introduction:

Wentworth Institute of Technology's Government Contract Department in accordance with the particulars of USAF contract No. F19628-79-C-0103 with the Air Force Geophysics Laboratory at Hanscom AFB, participates in the design, development, fabrication and servicing of electrical, electromechanical and mechanical systems and devices used to support the collection of data from outer space.

Scope:

This report is a record and analysis of the flight data and a verification of the AGE operation of the WIT/AFC support system segments for the project SPICE-2 (A24.782-3), launched 14 September 1982 from WSMR.

The three main system segments are:
1) AGE Interfaces
2) Vehicle Support Function
3) Payload Support Function

These system segments are subdivided into the following areas:

1) <u>AGE interfaces</u>

a) Launch Pad Interface
   1) Pullaway cable installation
   2) Range cable facilities check

b) Block House Interface
   1) User interface to range cable facilities
   2) Payload monitor and control functions
   3) Payload battery conditioning

2) <u>Vehicle Support Functions</u>

a) Power distribution
b) Temperature measurements
c) Vehicle related functions

3) <u>Payload Support Functions</u>

a) Time line generation
b) Power distribution system
c) Sensor deployment system
d) Temperature measurements
e) Payload related functions

Summary:

The overall performance of the three main system segments was highly satisfactory. Minor problems were encountered with three temperature measurements, T4A (Ambient Temp.), T3B (Aspect skin) and T16D (Nose Cone). These malfunctions were not important enough to delay the flight.

The other system segments, AGE, Vehicle and Payload Support Functions, operated as projected prior to launch and during the mission's flight phase.

Recommendations:

An evaluation of the temperatures ranges be made so that those areas where the temperature did not rise as expected have a new scale.

CONCLUSION

A.G.E. Interfaces:

No major problems were encountered with the payload's A.G.E. interfaces. All payload monitors and control systems performed as expected prior to launch. The battery charging system for the internal batteries, also performed satisfactorily.

Vehicle Support Functions:

An analysis of the recorded data for these subdivisions, power distribution, temperature measurements, and related functions, revealed no abnormalities.

WIT/AFC supplied a +28 volts battery pack (SN B159) to power the third link instrumentation. Results (page 8) indicated that this unit provided adequate power for the third link's operation. Voltage levels were 32.1v at T-0 and 30.6v at T+600.

All temperature monitors on the headcap and transmitter registered normal temperature changes during the concerned time frame of T-0 to T+90. Headcap temperature results (page 12 & 13) indicated hot spots on both the dome and the heat sink. Dome temperature monitor T#38 reached 154°C at T+80 and heat sink temperature monitor T#18 reached 66.1° C at T+90. A map of the headcap temperature monitors is shown on page 32.

The other related vehicle functions, B+ monitors and magnetometer measurements, operated as planned during the flight profile T-0 to T+600 seconds.

Payload Support Functions:

The analysis of the data showed that this system segment's functions, the time line generation, the power distribution, the sensor deployment, the temperature measurements, and the payload related functions operated as expected from T-120 sec. to T+600 sec. Loss of signal occured prior to T+900 sec. The recovered payload indicated that the T+900 sec. function had operated properly (power off, vent heater on).

The generation of the Time Line was controlled by two payload timers (WIT Digital Timer Model 206 Sn012 and Sn013). The data (page 16) indicates that the projected and actual time line were within the specified timing tolerance.

The power distribution system for this segment provided the power sources for four subsystems; the Payload Support, the Telemetry, the Starmapper, and the Experimenter. These power units were fabricated by WIT/AFC. Results on page 8 show that the specified voltage levels were maintained from T-30 (internal power) to T+800 (loss of signal) and the analog data showed no abnormalities during this time frame for all four subsystems. The voltage specifications for the four subsystems were:
1) Payload Support, (a) 28.0v ±3.0v, (b) Deployment, 28.0v ±3.0v. 2) TM. (a) Link 1, 28.0v ±3.0v, (b) Link 2, 28.0v ±3.0v. 3) Starmapper, 28.0v ±3.0v. 3) Experimenter, (a) ±24v ±3v, (b) ±16v ±3v, (c) 8v ±2v.

The Sensor Deployment System can be divided into two major segments. The first segment's function was the removal of all obstacles; the latch, the door, and the cap prior to sensor deployment. The second segment's function was the control of the sensor deployment program, the deploy, step and stowing actions.

The analog data (page 17-19) relating to switch positions and motor drives showed that all functions operated as anticipated during the first segment.

The sensor deployment results (page 7) and the sensor position data (page 21) indicated that the second segment also operated as expected.

The control of the sensor's deployment program was accomplished by three main components; the shaft encoder (Baldwin Model 232/5A-2 SN 771637), the logic control unit (WIT/LCU SN-102), and the sensor's drive system. The interaction of these components produced the following pertinent sensor deployment program parameters:

1) from the stow position to data collection point (DCP)#1 - a deployment time of 11.0 sec.
2) excluding the turnaround - an average step time of 0.577 sec.
3) from DCP#10 to DCP#11 - a turnaround time of 0.85 sec.
4) from DCP#20 to stow position - a stow time of 3.80 sec.
5) the drive system's rate of speed at high power = an angular velocity of 14.0°/sec.
6) the drive system's rate of speed at low power = a velocity of 1.36°/sec.
7) the total number of data collection points = twenty.
8) average position error from the projected value = 1.65 bits or 0.02 degree.
9) largest position error = 5 bits or 0.083 degree at DCP#10.

Temperature measurement within the payload was performed by twenty two thermister circuits configured for four different temperature ranges. Twenty of these monitors indicated temperature variation. Certain areas of the payload remained cooler than expected, suggesting that a more suitable temperature range be selected in the future for those areas.

A 0°C – 100°C temperature range was used to monitor three batteries and two transmitters. No unusual temperatures were observed for these items. The sensor battery (T-2A) reached a maximun temperature of 45.5°C during the flight. Transmitters 1 & 2 reached maximun levels of 66.5°C and 58.9 °C respectively at T+660 seconds.

The nose cone skin and the sensor door temperature monitors used the 60°C – 180°C range. Results showed the nose cone and the door reached maximum temperature levels of 113°C and 90.7°C respectively during the ascent, while on the descent, the nose cone and the door showed temperatures of 106°C and 93.7°C.

The 120°C – 240°C temperature range was used to monitor the remaining skin surfaces, the aspect skin, end plate and the weldment panels. A maximum temperature of 190 C was measured on the drive quadrant of the weldment panels. Three of the four temperature monitors on the aspect skin registered within this temperature range, with the maximum being 146°C for T4B. The end plate's temperature reached 117°C for T11B.

The fourth temperature range, 5°C to –65°C, was used to monitor the ACS gas bottle temperature. The data showed the lowest temperature reading of –27.1°C, occuring at T+596 sec.

The other payload related functions, pressure, attitude, and the acceleration of the payload, showed the following results;

The pressure within the payload was less than 0.5 psia by T+60 sec. as indicated on page 6 by the three pressure transducers. The pressure monitors also indicated that the payload started to enter the earth's atmosphere at approximately T+600 sec.

The recorded data from the accelerometers and magnetometers on pages 30 and 30A, indicated normal diagnostic information. The peak acceleration was 10.5 G at T+58.1 sec. A 13.0 G level was registered during separation at T+78.0 sec. The pitch and roll maneuvers were detected by the magnetometers from T+92 sec. to T+555 sec.

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E.O.F. Report

Pressure Transducer Results:

Time (sec.)	Press. Xducer Cal. (Volts)	Rack Xducer Press.(psia)	Mnfld. Xducer Press.(psia)	Cavity Xducer Press.(psia)
00.0	5.11	13.1	13.1	*
10.0	5.11	11.3	11.5	*
20.0	5.11	08.6	07.5	*
30.0	5.11	03.7	03.0	*
40.0	5.11	01.6	01.2	01.7
50.0	5.11	00.5	00.4	00.3
60.0	5.11	00.4	00.3	00.1
70.0	5.11	00.4	00.3	00.1
580	5.16	00.2	00.3	00.1
590	5.16	00.2	00.3	00.1
600	5.16	01.1	01.2	01.0
610	5.16	03.0	01.2	01.8
620	5.16	01.8	01.2	*
630	5.19	01.9	02.0	*
640	5.19	02.4	02.8	*
650	5.19	03.3	03.2	*
660	5.19	03.4	03.2	*

* Voltage readings for these times beyond calibration data.

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oll Rate and Sensor Deployment Results:

ime sec.)	Data pt.	Sensor Angle deg.	Period (sec.)	Payload roll Rate deg./sec.	Mag. Roll Rate deg./sec.
+102.7	1	42.2	19.2	23.3	16.7
+122.5	2	46.3	18.0	21.4	19.8
+141.2	3	50.8	19.3	20.0	18.6
+161.2	4	54.9	21.4	18.8	16.2
+183.5	5	59.1	21.4	17.6	16.4
+205.6	6	63.5	22.9	17.1	16.0
+229.2	7	67.8	23.2	16.5	15.1
+253.5	8	72.2	25.3	15.9	14.3
+279.5	9	76.6	23.0	15.6	15.3
+303.4	10	80.9	25.9	15.3	13.5
+330.1	11	83.0	25.1	15.1	14.2
+355.6	12	78.7	25.1	15.3	14.8
+381.4	13	74.4	24.6	15.6	15.3
+406.5	14	70.0	24.0	16.0	15.6
+431.0	15	65.8	23.4	16.5	15.7
+454.9	16	61.4	22.3	17.1	16.6
+477.6	17	57.4	21.5	17.9	17.6
+499.6	18	52.9	19.7	18.8	19.0
+519.7	19	48.6	20.9	20.0	18.4
+541.1	20	44.1	16.6	21.4	21.9

NOTE: Payload Rate marker set to 382.5 degrees.

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ttery B+ Monitor Results: in volts

Time (sec.)	-30.0	0.00	200	400	600	800
v. Support Battery	29.5	29.2	28.9	28.4	28.1	27.9
v. Deployment Bat.	32.8	32.6	31.2	30.9	30.6	30.3
ar Mapper Battery	29.2	28.9	28.7	28.4	28.4	28.4
M Link I Battery	27.8	27.6	27.3	26.7	26.4	26.4
M Link II Battery	28.4	28.1	27.8	27.3	26.7	26.7
M Link III Battery	32.2	32.1	31.2	30.9	30.6	*
4v. Sensor Battery	25.6	25.5	25.0	24.8	24.7	24.6
4v. Sensor Battery	-25.4	-25.3	-25.2	-25.0	-24.8	-24.7
6v. Sensor Battery	16.7	16.7	16.7	16.7	16.6	16.6
6v. Sensor Battery	-16.8	-16.7	-16.6	-16.5	-16.5	-16.5
8v. Sensor Battery	9.6	9.6	9.5	9.4	9.3	9.1

Conversion Formulas:

Support, StarMapper, T/M Links I-III, and
+28v Sensor Batteries = (2.80 x Eo) + 20.0

+24v Sensor Battery = (1.8 x Eo) + 18.0

-24v Sensor Battery = (-1.8 x Eo) - 18.0

+16v Sensor Battery = (1.4 X Eo) + 11.0

-16v Sensor Battery = (-1.4 X Eo) -11.0

+8v Sensor Battery = (1.4 X Eo) + 3.3

Not monitored past 600 sec.

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E.O.F. Report

tery B+ Monitor Data: T.M. output in volts

Time (sec.)	-30.0	0.00	200	400	600	800
Support Battery	3.40	3.30	3.20	3.00	2.90	2.85
Deployment Battery	4.60	4.50	4.00	3.90	3.80	3.70
ır Mapper Battery	3.30	3.20	3.10	3.00	3.00	3.00
l Link I Battery	2.80	2.70	2.60	2.40	2.30	2.30
l Link II Battery	3.00	2.90	2.80	2.60	2.40	2.40
l Link III Battery	4.36	4.32	4.00	3.88	3.80	*
lv Sensor Battery	4.20	4.15	3.90	3.80	3.70	3.65
lv Sensor Battery	4.10	4.05	4.00	3.90	3.80	3.75
›v Sensor Battery	4.10	4.08	4.06	4.04	4.00	4.00
›v Sensor Battery	4.20	4.10	4.00	3.95	3.90	3.90
3v Sensor Battery	4.50	4.48	4.40	4.35	4.30	4.15

NOTE: * Not monitored past 580 sec.

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E.O.F. Report

nsor's Data Collection Positions:

ta Point	Projected Value (Octal)	Projected Angle (degrees)	Measured Value (Octal)	Stepping Time (sec.)
Stowed	17712	0.00	17711	----
# 1	12766	42.144	12770	11.0
# 2	12366	46.434	12370	0.65
# 3	11766	50.720	11770	0.67
# 4	11366	55.008	11370	0.67
# 5	10766	59.296	10766	0.65
# 6	10366	63.584	10370	0.70
# 7	7766	67.872	7771	0.65
# 8	7366	72.160	7370	0.75
# 9	6766	76.448	6771	0.70
#10	6366	80.736	6373	0.96
#11	6166	82.880	6170	0.85
#12	6566	78.592	6567	0.45
#13	7166	74.304	7167	0.60
#14	7566	70.016	7567	0.50
#15	10166	65.728	10167	0.50
#16	10566	61.440	10567	0.50
#17	11166	57.152	11166	0.45
#18	11566	52.864	11567	0.50
#19	12166	48.576	12167	0.45
#20	12566	44.281	12567	0.50
Stowed	17712	0.00	17711	3.80

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ressure Transducer Data:

ime sec.)	Press. Xducer Cal. (Volts)	Rack Xducer Press. (Volts)	Mnfld. Xducer Press. (Volts)	Cavity Xducer Press. (Volts)
0.0	5.11	4.26	4.36	10.0
0.0	5.11	3.71	3.85	10.0
0.0	5.11	2.85	2.56	10.0
0.0	5.11	1.31	1.10	10.0
0.0	5.11	0.62	0.51	4.39
0.0	5.11	0.30	0.26	0.68
0.0	5.11	0.25	0.20	0.00
0.0	5.11	0.25	0.20	0.00
80	5.11	0.19	0.20	0.00
90	5.11	0.19	0.20	0.00
00	5.16	0.49	0.51	2.56
10	5.16	1.09	0.51	5.07
20	5.16	0.69	0.51	3.34
30	5.19	0.74	0.79	4.41
40	5.19	0.89	1.02	5.99
50	5.19	1.16	1.15	8.05
60	5.19	1.19	1.15	8.05

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E.O.F. Report

Motor Direction Monitors, Analog Data

ll values are in volts.

oor and Latch Motors:

Function	Projected Value	Measured Value
oor Closed	0.0	0.0
oor Unlatching	2.2	2.2
oor Opening	4.3	4.7
oor Opened	0.3	0.4
oor Closing	3.3	3.5
oor Latching	1.0	0.8

ensor Motor And Brake:

Function	Projected Value	Measured Value
otate Out: Hi Power	1.8	2.1
otate Out: Lo Power	0.4	0.4
otate In: Hi Power	1.1	1.2
otate In: Lo Power	0.2	0.3
rake	3.4	3.8

ap Motor:

Function	Projected Value	Measured Value
ap Replaced @ Lo Power	0.3	0.3
ap Being Removed	2.3	2.2
ap Removed	0.0	0.0
ap Being Replaced	4.7	4.3

tartracker + Mapper Motors:

Function	Projected Value	Measured Value	
pening Direction	4.4	Star. 5.0	Map. 4.8
losing Direction	2.2	2.3	2.2

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Sensor Door Position Monitors (OPENING):

All values are in volts unless otherwise noted

Time (sec.) T+	0.00	21.0	80.0	83.0	86.0	90.0	92.0	94.0
Unlatching	0.0	0.0	4.9	0.0	0.0	0.0	0.0	0.0
Unlatched	0.0	0.0	0.0	5.0	5.0	0.0	0.0	0.0
Opening	0.0	0.0	0.0	0.0	5.0	5.0	4.3	0.6
Opened *	0.0	0.0	0.0	0.0	0.0	4.9	4.9	0.0
Closing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Closed	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latching	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latched	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* Door opened to 112.9 degrees.

Sensor Door Position Monitors (CLOSING):

All values are in volts unless otherwise noted

Time (sec.) T+	561.0	568.0	571.0	585.0
Unlatching	0.0	0.0	0.0	0.0
Unlatched	0.0	0.0	0.0	0.0
Opening	0.6	0.0	0.0	0.0
Opened	0.0	0.0	0.0	0.0
Closing	5.0	5.0	1.7	0.0
Closed	0.0	0.0	5.0	5.0
Latching	0.0	4.9	4.9	0.0
Latched	0.0	0.0	0.0	0.0

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E.O.F. Report

Position Monitors, Analog Data:

All values are in volts unless otherwise noted

Time (sec.)	0.00	12.7	84.3	90.5	94.0	100	560	567	568	600
Sensor Cover ON	0.0	0.0	-	-	-	-	-	-	0.5	0.5
Sensor Cover Being Removed	-	-	2.2	2.2	-	-	-	-	-	-
Sensor Cover Removed	-	-	-	-	0.0	0.0	-	-	-	-
Sensor Cover Being Replaced	-	-	-	-	-	-	4.3	4.3	-	-
Sensor Cover ON	0.0	0.0	-	-	-	-	-	-	0.5	0.5
Tracker & Mapp. Door Closed	0.5	-	-	-	-	-	-	-	-	-
Trac. Door Open Mapp. Door Clsd	-	1.0	1.0	1.0	-	-	-	-	-	-
Trac. Door Open Mapp. Door Open	-	-	-	-	1.9	1.9	1.9	1.9	-	-
Trac. Door Clsd Mapp. Door Clsd	-	-	-	-	-	-	-	-	1.0	1.0

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E.O.F. Report

Time Line, Data:

	Projected			Actual		
	Event No.	Projected Time (sec.)	Action Time (sec.)	Flight Time (sec.)	Action Time (sec.)	Event
*	3	74.0	10.0	73.7	10.1	Logic Reset
*	10	80.0	3.0	79.3	2.0	Unlatch Sensor Door
*	11	82.0	-	-	-	Blackbody Calibration
*	13	87.5	-	-	-	Diode Pulse Calibration
*	14	85.0	5.0	84.3	6.3	Remove Sensor Cap
*	15	85.0	6.0	90.2	5.2	Open Sensor Door 90 degrees
*	18	92.0	2.0	93.5	2.0	Open Tracker Door
*	19	92.0	8.0	93.6	-	Open Aspect Door
*	20	92.0	8.0	91.8	11.0	Start Sensor Deployment
*	24	558.0	-	557.8	-	Start Sensor Stow
	25	558.0	7.0	559.8	7.0	Close Sensor Door
	26	558.0	5.0	559.8	4.9	Replace Sensor Cap
	29	568.0	2.0	567.3	2.0	Close Tracker Door
	30	568.0	8.0	-	-	Close Aspect Door
	31	568.0	4.0	567.9	-	Start Latching Sensor Door
	32	568.0	-	589.4	21.5	Latching Complete
*	36	900.0	-	LOS	-	Payload Power Off

* These events are initiated directly from timer commands.

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E.O.F. Report

Door Potentiometer Position, Results:

Time (sec.)	0.00	87.0	90.0	91.0	92.0	92.4
Degrees	0.00	25.1	84.6	96.5	108	112.5

Time (sec.)	560	561	562	564	564.2
Degrees	112.5	109	75.2	45.7	0.00

Conversion Formulas:

$$\frac{-116.7}{Va} \times Vo + 116.7 = \text{Degree}$$

$$Va = 5.10\ v$$

REPORT.15

SPICE-2 (A24.782-3)

E.O.F. Report

Sensor Potentiometer Position, Results:

	Stow	DCP#1	DCP#2	DCP#3	DCP#4	DCP#5	DCP#6
Time (sec.)	0.0	104	123	142	162	184	206
Angle (Deg.)	0.0	42.2	46.3	50.8	54.9	59.1	63.5

	DCP#7	DCP#8	DCP#9	DCP#10	DCP#11	DCP#12	DCP#13
Time (sec.)	229	253	278	304	330	356	381
Angle (Deg.)	67.8	72.2	76.6	80.9	83.0	78.7	74.4

	DCP#14	DCP#15	DCP#16	DCP#17	DCP#18	DCP#19	DCP#20
Time (sec.)	406	431	455	477	499	520	541
Angle (Deg.)	70.0	65.8	61.4	57.4	52.9	48.6	44.1

Conversion Formulas:

$$33.5 \le \text{Angle} \le 49.0 = -14.7\ Vo/Va + 49.0$$
$$49.5 \le \text{Angle} \le 64.5 = -14.7\ Vo/Va + 64.5$$
$$65.0 \le \text{Angle} \le 80.0 = -14.7\ Vo/Va + 80.0$$
$$80.5 \le \text{Angle} \le 95.5 = -14.7\ Vo/Va + 95.5$$

Va = 5.10 v

SPICE-2 (A24.782-3)

E.O.F. Report (Aux.Box # 2 H.T.)

Headcap High Temp. Monitors, Data: in degrees Celcius

Time (sec.)	0.00	30.0	50.0	60.0	80.0	90.0
Measured Voltage Ref.	9.95	9.95	9.95	9.95	9.95	9.95
Temp. Mon. # 21	29.0	46.9	70.5	92.9	130	119
Temp. Mon. # 22	**	34.0	52.6	73.9	97.6	92.3
Temp. Mon. # 23	101.3	104.5	109.3	118.9	123	116
Temp. Mon. # 24	22.2	34.0	45.7	59.2	112	98.6
Temp. Mon. # 25	26.7	35.5	48.0	55.9	98.6	**
Temp. Mon. # 26	22.2	38.7	55.9	70.0	114	107
Temp. Mon. # 27	35.5	37.1	46.9	57.6	90.2	95.5
Temp. Mon. # 28	26.7	35.5	48.0	56.7	95.5	110
Temp. Mon. # 29	34.0	40.2	55.0	66.9	97.2	100
Temp. Mon. # 30	22.2	37.1	57.6	71.5	107	104
Temp. Mon. # 31	22.2	34.0	51.8	66.2	99.7	93.3
Temp. Mon. # 32	34.0	37.1	46.9	60.0	79.3	80.2
Temp. Mon. # 33	26.7	50.2	52.6	45.6	97.2	81.5
Temp. Mon. # 34	29.0	41.3	67.5	89.7	122	87.7
Temp. Mon. # 35	22.2	30.8	54.2	69.4	105	94.4
Temp. Mon. # 36	30.8	35.5	55.0	71.5	110	98.3
Temp. Mon. # 37	**	30.8	44.6	58.3	92.3	97.9
Temp. Mon. # 38	24.4	48.0	59.2	87.3	154	142

NOTES: - Temperature monitors T21 to T38 are for a temperature range of 60°C to 190°C.

- See appendix for V-T curve.

SPICE-2 (A24.782-3)

E.O.F. Report (Aux.Box # 1 L.T.)

Headcap Low Temp. Monitors, Data: in degrees Celcius

Time (sec.)	00.0	30.0	50.0	60.0	80.0	90.0
Measured Voltage Ref.	9.87	9.87	9.87	9.87	9.87	9.87
Temp. Mon. # 1	25.5	28.3	35.6	39.7	52.1	54.6
Temp. Mon. # 2	25.1	27.3	40.1	45.5	58.3	60.3
Temp. Mon. # 3	25.4	29.8	38.1	40.5	58.7	59.0
Temp. Mon. # 4	23.3	25.6	31.2	35.4	46.4	49.1
Temp. Mon. # 5	25.4	27.0	32.6	37.2	49.3	49.9
Temp. Mon. # 6	24.4	27.0	32.3	37.4	49.6	52.1
Temp. Mon. # 7	24.1	25.8	31.2	37.1	47.0	48.8
Temp. Mon. # 8	24.4	26.4	33.5	39.3	51.7	53.3
Temp. Mon. # 9	*	27.0	30.9	40.5	52.8	55.3
Temp. Mon. # 10	24.4	30.1	39.9	47.7	60.3	61.5
Temp. Mon. # 11	25.8	27.9	34.9	41.6	59.5	62.4
Temp. Mon. # 12	24.9	26.4	33.5	38.3	48.5	51.2
Temp. Mon. # 13	25.3	27.5	34.8	40.7	55.8	56.5
Temp. Mon. # 14	24.4	25.9	46.0	38.4	52.1	53.8
Temp. Mon. # 15	23.9	25.4	31.3	36.3	42.7	53.8
Temp. Mon. # 16	24.9	28.0	36.6	42.7	53.8	56.0
Temp. Mon. # 17	24.8	29.8	41.6	2.31	61.2	65.1
Temp. Mon. # 18	25.6	29.0	38.8	45.8	60.1	66.1
Temp. Mon. # 19	24.1	25.6	32.2	37.8	51.7	57.4
Temp. Mon. # 20	25.1	28.1	38.1	45.7	59.7	64.7

Third Link Batt. + Xmtr. Temp. Monitors, Data: in degrees Celcius

Time (sec.)	0.00	100	200	300	400	500	580
Battery Temp.	44.5	44.5	44.5	45.4	45.6	45.8	46.5
XMTR Temp.	60.3	63.3	64.9	68.6	71.7	72.3	74.7

NOTES: - Temp. monitors T1 to T20 are for temp. range 10 to 90 degrees Celcius.
- See appendix for V-T curve.

SPICE-2 (A24.782-3)

E.O.F. Report

Temperature Monitors, T7B - T12B, Data: in degrees Celcius

Time (sec.) T+	30.0	60.0	90.0	120	600	630	660	690
Cal.Measurement (T1B - T12B)	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Brake Quad. Temp.-T7B	34.4	102	99.6	96.7	96.7	84.1	52.3	**
Drive Quad. Temp.-T8B	**	90.7	93.7	90.7	105	143	118	52.3
W.I.T. Access Door Temp.-T9B	34.4	63.8	58.6	58.6	34.4	96.7	63.8	**
Sensor Door Temp.T10B	52.3	**	90.7	87.5	93.7	62.7	44.5	44.5
End Plate Temp.#3-T11B	18.7	18.7	18.7	18.7	80.6	68.7	34.4	18.7
End Plate Temp.#4-T12B	18.7	18.7	18.7	18.7	96.8	80.6	44.5	18.7

NOTES: - Temperature monitors T7B-T12B are for temperature range 120°C to 240°C, except T10B, it is for temperature range 60°C to 180°C.
- See appendix for V-T curve.

- ** Temperature remained below design minimum.

SPICE-2 (A24.752-3)

E.O.F. Report

Temperature Monitors, T1B - T6B, Data: in degrees Celcius

Time (sec.) T+	30.0	60.0	90.0	120	600	630	660	690
Cal.Measurement (T1B - T12B)	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Aspect Skin Temp.#1-T1B	**	86.7	96.4	73.8	53.2	53.2	**	**
Aspect Skin Temp.#2-T2B	**	**	**	**	53.2	**	**	**
Aspect Skin Temp.#3-T3B	**	**	**	**	**	**	**	**
Aspect Skin Temp.#4-T4B	**	80.9	80.9	73.8	123	111	73.8	**
End Plate Temp.#1-T5B	**	**	**	**	86.7	111	80.9	73.8
End Plate Temp.#2-T6B	**	**	**	**	86.7	111	86.7	73.8

NOTES: - Temperature monitors T1B-T6B are for temperature range $120^{o}C$ to $240^{o}C$.
- See appendix for V-T curve.
- Asterisks are used where the temperature remained too far below the predicted range to produce useable data.

SPICE-2 (A24.782-3)

E.O.F. Report

Temperature Monitors, T1A - T4A, Data: in degrees Celcius

Time (sec.) T+	30.0	60.0	90.0	120	600	660	720	780
Cal. Measurement (T1A - T4A)	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Link I Xmtr. Temp.-T1A	55.0	55.0	56.7	56.7	64.3	66.5	66.5	66.5
Sensor +24V Batt. Temp.-T2A	48.5	48.5	48.5	48.5	48.5	*	*	48.5
Support Battery Temp.-T3A	46.3	48.5	48.5	46.3	46.3	46.3	46.3	46.3
Ambient Temp.-T4A	14.1	13.6	14.1	14.1	16.1	16.1	16.1	16.1

Temperature Monitors, T13D - T16D, Data: in degrees Celcius

Time (sec.) T+	30.0	60.0	90.0	120	600	660	720	780
Cal. Measurement (T13D - T18D)	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7
ACS Gas Bottle Temp.-T13D	26.1	26.1	20.6	13.1	-20.2	-3.9	07.1	09.6
Nose Cone Skin Temp.-T14D	50.2	108	113	103	106	91.7	56.3	31.3
Nose Cone Skin Temp.-T15D	31.3	78.7	91.7	88.7	78.7	97.5	71.1	71.1
Link II Xmtr. Temp.-T17D	47.8	47.8	47.8	47.8	55.7	57.3	58.9	58.9
Deployment Batt. Temp.-T18D	45.4	45.4	45.4	45.4	45.4	*	*	45.4

NOTES:- Temperature monitors T1A-T4A are for temp. range 0°C to 100°C.
- Temperature monitors T14D-T16D for temp. range 60°C to 180°C.
- Temperature monitor T13D is for temp. range 5°C to -65°C.
- See appendix for V-T curve.

REPORT.9

SPICE-2 (A24.782-3)

E.O.F. Report

Temperature Monitors, T1A - T4A, Data: T.M. output in volts

Time (sec.) T+	30.0	60.0	90.0	120	600	660	720	780
Cal.Measurement (T1A - T4A)	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Link I Xmtr. Temp.-T1A	2.1	2.1	2.0	2.0	1.6	1.5	1.5	1.5
Sensor +24V Batt. Temp.-T2A	2.9	2.9	2.9	2.9	2.9	*	*	2.9
Support Battery Temp.-T3A	3.0	2.9	2.9	3.0	3.0	3.0	3.0	3.0
Ambient Temp.-T4A	5.2	5.3	5.2	5.2	5.1	5.1	5.1	5.1

Temperature Monitors, T13D - T18D, Data: T.M. output in volts

Time (sec.) T+	30.0	60.0	90.0	120	600	660	720	780
Cal.Measurement (T13D - T18D)	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
ACS Gas Bottle Temp.-T13D	0.5	0.5	0.6	0.8	2.7	1.5	1.0	0.9
Nose Cone Skin Temp.-T14D	5.0	3.4	3.2	3.6	3.5	4.0	4.9	5.2
Nose Cone Skin Temp.-T15D	5.2	4.4	4.0	4.1	4.4	3.8	4.6	4.6
Link II Xmtr. Temp.-T17D	2.6	2.6	2.6	2.6	2.1	2.0	1.9	1.9
Deployment Batt. Temp.-T18D	3.1	3.1	3.1	3.1	3.1	*	*	3.1

NOTES:
- Temperature monitors T1A-T4A are for temp. range 0°C to 100°C.
- Temperature monitor T14D&T15D are for temp. range 60°C to 180°C.
- Temperature monitor T13D is for temp. range 5°C to -65°C.
- See appendix B for V-T curves, 1, 2, 5, 6, 7, & Gas Bottle.

SPICE-2 (A24.782-3)

E.O.F. Report

Temperature Monitors, T1B - T6B, Data: T.M.output in volts

Time (sec.) T+	30.0	60.0	90.0	120	600	630	660	690
Cal.Measurement (T1B - T12B)	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Aspect Skin Temp.#1-T1B	5.3	4.9	4.8	5.0	5.1	5.1	5.3	5.5
Aspect Skin Temp.#2-T2B	5.3	5.2	5.2	5.3	5.1	5.2	5.3	5.4
Aspect Skin Temp.#3-T3B	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Aspect Skin Temp.#4-T4B	5.3	5.0	5.05	5.0	4.4	4.6	5.0	5.3
End Plate Temp.#1-T5B	5.2	5.2	5.2	5.3	4.9	4.6	5.0	5.0
End Plate Temp.#2-T6B	5.3	5.3	5.3	5.3	4.9	4.6	4.9	5.0

NOTES: - Temperature monitors T1B-T6B are for temperature range $120^{o}C$ to $240^{o}C$.
- See appendix B for V-T curve, 3.

SPICE-2 (A24.782-3)

E.O.F. Report

Temperature Monitors, T7B - T12B, Data: T.M. output in volts

Time (sec.) T+	30.0	60.0	90.0	120	600	630	660	690
Cal.Measurement (T1B - T12B)	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Brake Quad. Temp.-T7B	5.0	3.5	3.6	3.7	3.7	4.1	4.8	5.2
Drive Quad. Temp.-T8B	5.4	3.9	3.8	3.9	3.4	2.0	2.9	4.8
W.I.T. Access Door Temp.-T9B	5.0	4.6	4.7	4.7	5.0	3.7	4.6	*
Sensor Door Temp.T10B	4.9	5.9	3.9	4.0	3.8	4.5	4.9	4.9
End Plate Temp.#3-T11B	5.1	5.1	5.1	5.1	4.2	4.5	5.0	5.1
End Plate Temp.#4-T12B	5.1	5.1	5.1	5.1	4.3	4.2	4.9	5.1

NOTES: - Temperature monitors T7B-T12B are for temperature range 120^oC to 240^oC, except T10B, it is for temperature range 60^oC to 180^oC.
- See appendix B for V-T curve 4.

SPICE-2 (A24.782-3)

E.O.F. Report (Aux.Box # 1 L.T.)

Headcap Low Temp. Monitors, Data: T.M. output in volts

Time (sec.)	00.0	30.0	50.0	60.0	80.0	90.0
Measured Voltage Ref.	3.95	3.95	3.95	3.95	3.95	3.95
Temp. Mon. # 1	4.07	3.85	3.28	2.96	2.14	2.00
Temp. Mon. # 2	4.10	3.93	2.93	2.56	1.79	1.68
Temp. Mon. # 3	4.08	3.73	3.08	2.70	1.77	1.75
Temp. Mon. # 4	4.25	4.06	3.62	3.29	2.50	2.32
Temp. Mon. # 5	4.08	3.95	3.51	3.15	2.30	2.26
Temp. Mon. # 6	4.16	3.95	3.53	3.14	2.28	2.14
Temp. Mon. # 7	4.18	4.05	3.62	3.16	2.46	2.34
Temp. Mon. # 8	4.16	4.00	3.44	2.99	2.16	2.07
Temp. Mon. # 9	1.14	3.95	3.64	2.90	2.10	1.96
Temp. Mon. # 10	4.16	3.70	2.94	2.41	1.68	1.63
Temp. Mon. # 11	4.05	3.88	3.33	2.83	1.72	1.59
Temp. Mon. # 12	4.12	4.00	3.44	3.07	2.36	2.19
Temp. Mon. # 13	4.09	3.91	3.34	2.89	1.93	1.89
Temp. Mon. # 14	4.16	4.04	2.53	3.06	2.14	2.04
Temp. Mon. # 15	4.20	4.08	3.61	3.22	2.75	2.04
Temp. Mon. # 16	4.12	3.87	3.20	2.75	2.04	1.92
Temp. Mon. # 17	4.13	3.73	2.83	2.31	1.64	1.47
Temp. Mon. # 18	4.06	3.79	3.03	2.54	1.69	1.43
Temp. Mon. # 19	4.18	4.06	3.54	3.11	2.16	1.84
Temp. Mon. # 20	4.10	3.86	3.08	2.55	1.71	1.49

Third Link Batt. + Xmtr Temp. Monitors, Data:

Time (sec.)	0.00	100	200	300	400	500	580
Battery Temp.	2.90	2.90	2.90	2.86	2.85	2.84	2.81
XMTR Temp.	1.68	1.55	1.48	1.32	1.20	1.18	1.10

NOTES: - All temperature values are in volts unless otherwise noted.
- Temp. monitors T1 to T20 and XMTR are for temp. range 10 to 90 degrees Celsius.
- See appendix A for V-T curve.

SPICE-2 (A24.782-3)

E.O.F. Report (Aux.Box # 2 H.T.)

Headcap High Temp. Monitors, Data: T.M. output in volts

Time (sec.)	0.00	30.0	50.0	60.0	80.0	90.0
Measured Voltage Ref.	3.98	3.98	3.98	3.98	3.98	3.98
Temp. Mon. # 21	4.73	4.60	4.28	3.76	2.59	2.95
Temp. Mon. # 22	4.79	4.70	4.54	4.21	3.63	3.78
Temp. Mon. # 23	3.52	3.42	3.27	2.95	2.83	3.04
Temp. Mon. # 24	4.76	4.70	4.61	4.46	3.19	3.06
Temp. Mon. # 25	4.74	4.69	4.59	4.50	3.60	4.82
Temp. Mon. # 26	4.76	4.67	4.50	4.29	3.12	3.34
Temp. Mon. # 27	4.69	4.68	4.60	4.48	3.84	3.69
Temp. Mon. # 28	4.74	4.69	4.59	4.49	3.69	3.25
Temp. Mon. # 29	4.70	4.66	4.51	4.34	3.64	3.56
Temp. Mon. # 30	4.76	4.68	4.48	4.26	3.35	3.43
Temp. Mon. # 31	4.76	4.70	4.55	4.35	3.57	3.75
Temp. Mon. # 32	4.70	4.68	4.60	4.45	4.10	4.08
Temp. Mon. # 33	4.74	4.57	4.54	4.36	3.64	4.05
Temp. Mon. # 34	4.73	4.65	4.33	3.85	2.86	3.90
Temp. Mon. # 35	4.76	4.72	4.52	4.30	3.41	3.72
Temp. Mon. # 36	4.72	4.69	4.51	4.26	3.24	3.61
Temp. Mon. # 37	4.77	4.72	4.62	4.47	3.78	3.62
Temp. Mon. # 38	4.75	4.59	4.46	3.91	1.81	2.19

NOTES: - Temperature monitors T21 to T38 are for a temperature range of 60°C to 190°C.

- See appendix A for V-T curve.

SPICE-2 (A24.782-3)

E.O.F. Report

Sensor Potentiometer Position, Data: T.M. output in volts

	Stow	DCP#1	DCP#2	DCP#3	DCP#4	DCP#5	DCP#6
Time (sec.)	0.00	103	123	142	162	184	206
Voltage (Vo)	0.88	2.35	0.93	4.75	3.33	1.85	0.35

	DCP#7	DCP#8	DCP#9	DCP#10	DCP#11	DCP#12	DCP#13
Time (sec.)	230	254	280	304	331	356	382
Voltage (Vo)	4.23	2.70	1.17	5.05	4.32	0.43	1.94

	DCP#14	DCP#15	DCP#16	DCP#17	DCP#18	DCP#19	DCP#20
Time (sec.)	407	432	455	478	500	520	542
Voltage (Vo)	3.46	4.93	1.08	2.45	4.01	0.13	1.69

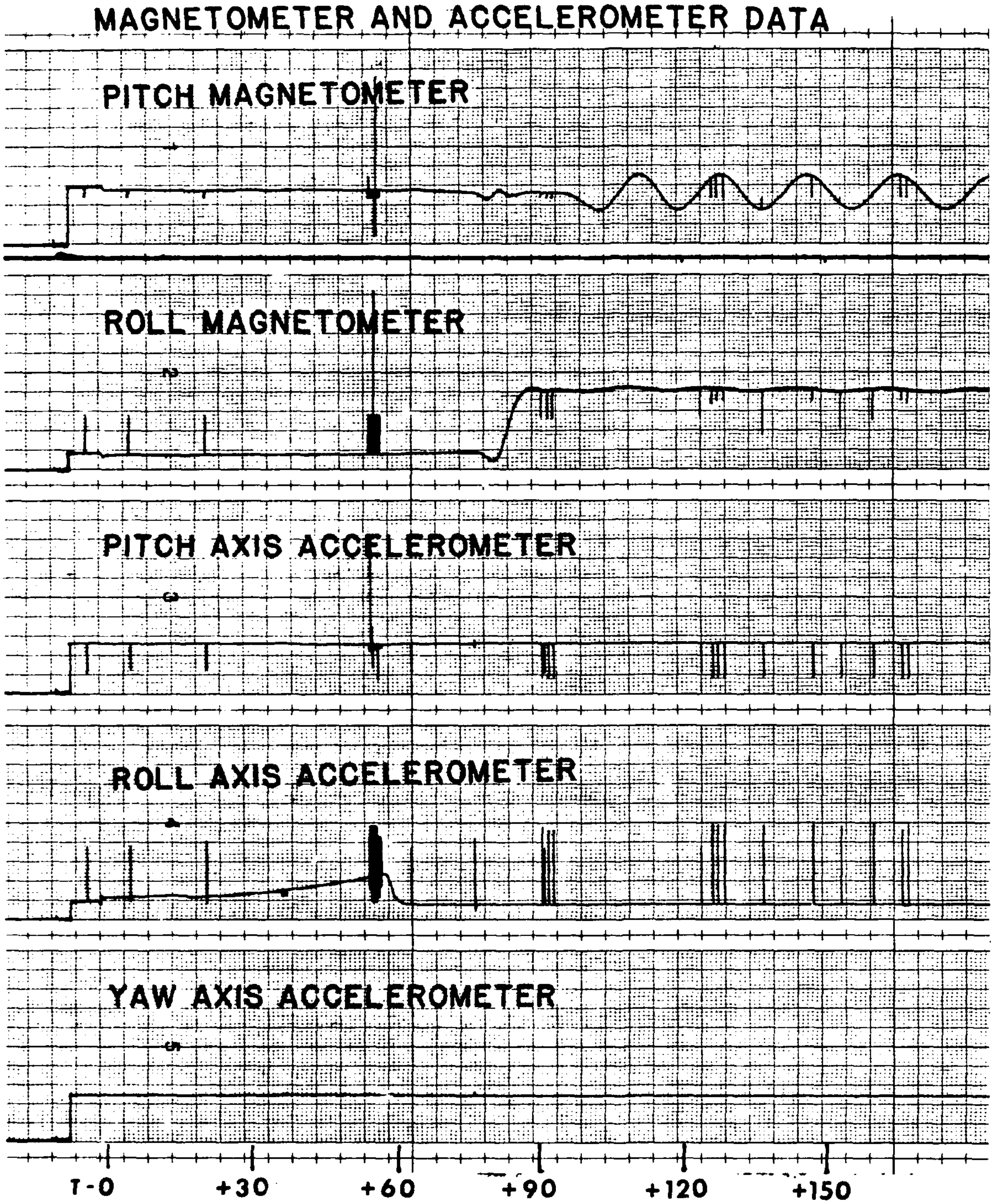
SPICE-2 (A24.782-3)

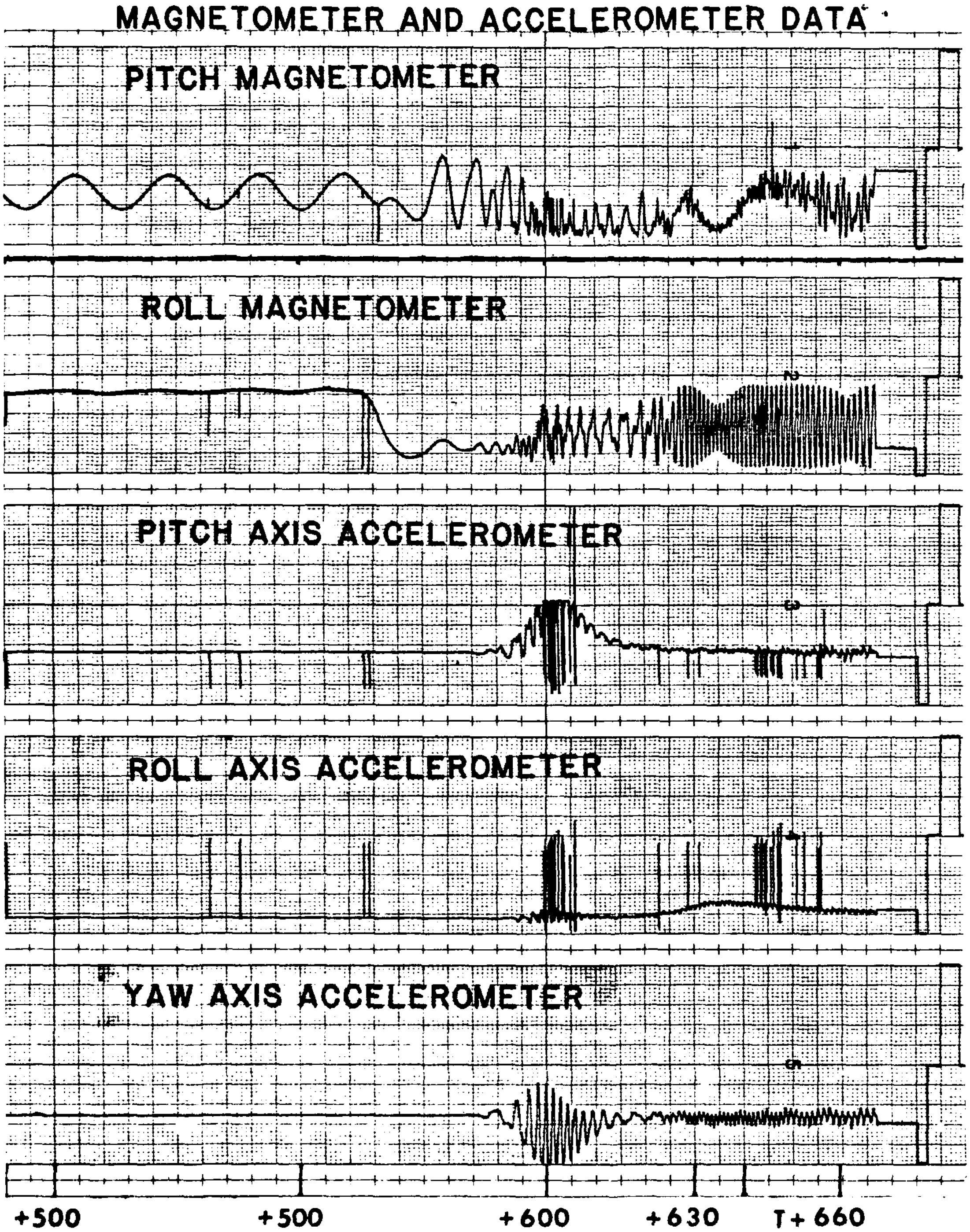
E.O.F. Report

Door Potentiometer Position, Data: T.M. output in volts

Time (sec.)	85.0	87.0	90.0	91.0	92.0	92.1
Voltage (Vo)	5.10	4.04	1.39	0.88	0.38	0.18

Time (sec.)	560	561	563	565	566	567
Voltage (Vo)	0.18	0.33	1.81	3.11	4.97	5.10


MAGNETOMETER AND ACCELEROMETER DATA
PITCH MAGNETOMETER
ROLL MAGNETOMETER
PITCH AXIS ACCELEROMETER
ROLL AXIS ACCELEROMETER
YAW AXIS ACCELEROMETER
T-0
+30
+60
+90
+120
+150



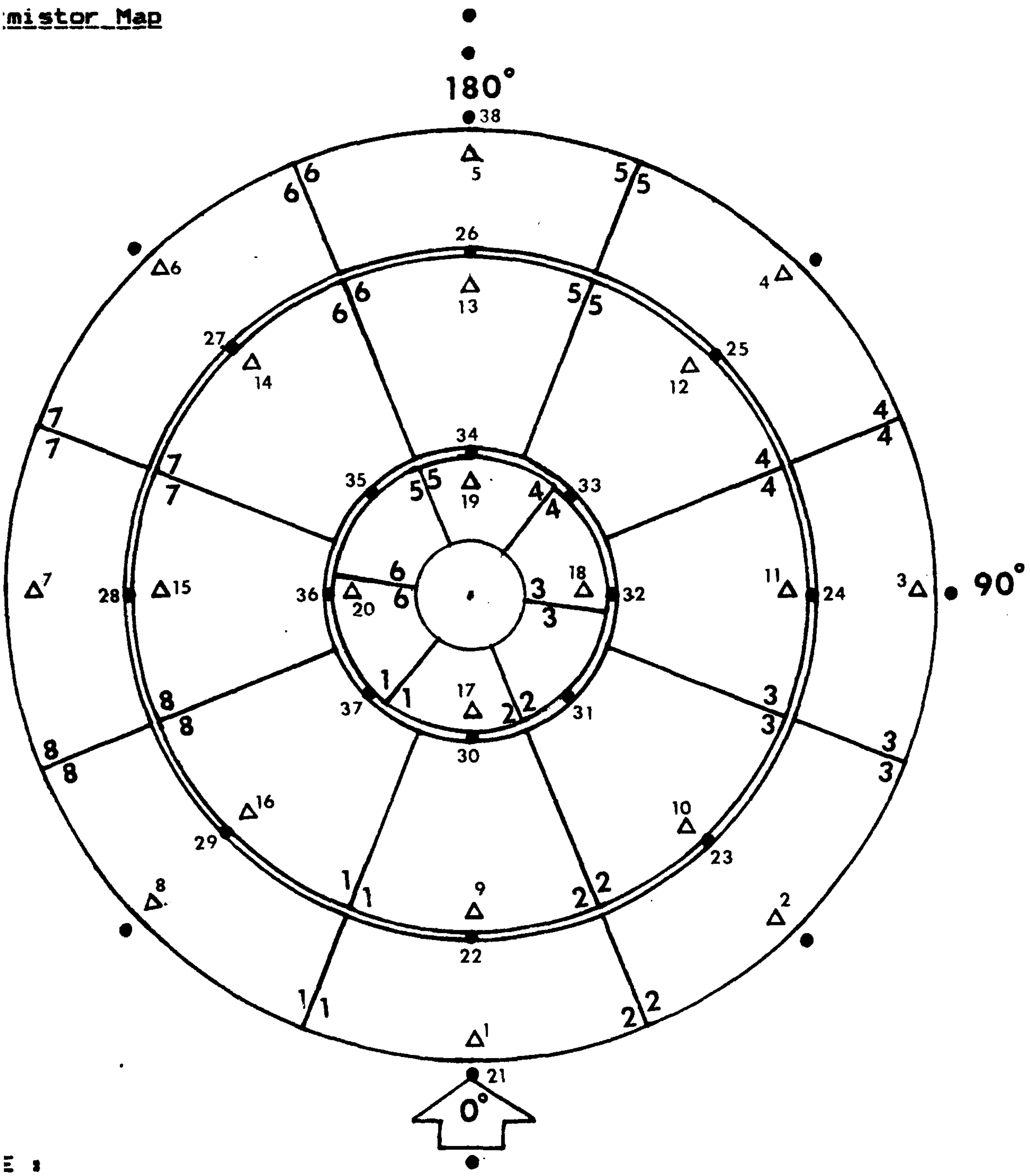
MAGNETOMETER AND ACCELEROMETER DATA
PITCH MAGNETOMETER
ROLL MAGNETOMETER
PITCH AXIS ACCELEROMETER
ROLL AXIS ACCELEROMETER
YAW AXIS ACCELEROMETER
+500
+500
+600
+630
T+660

Appendix A

Vehicle Headcap Thermistor Map and V-T Curves

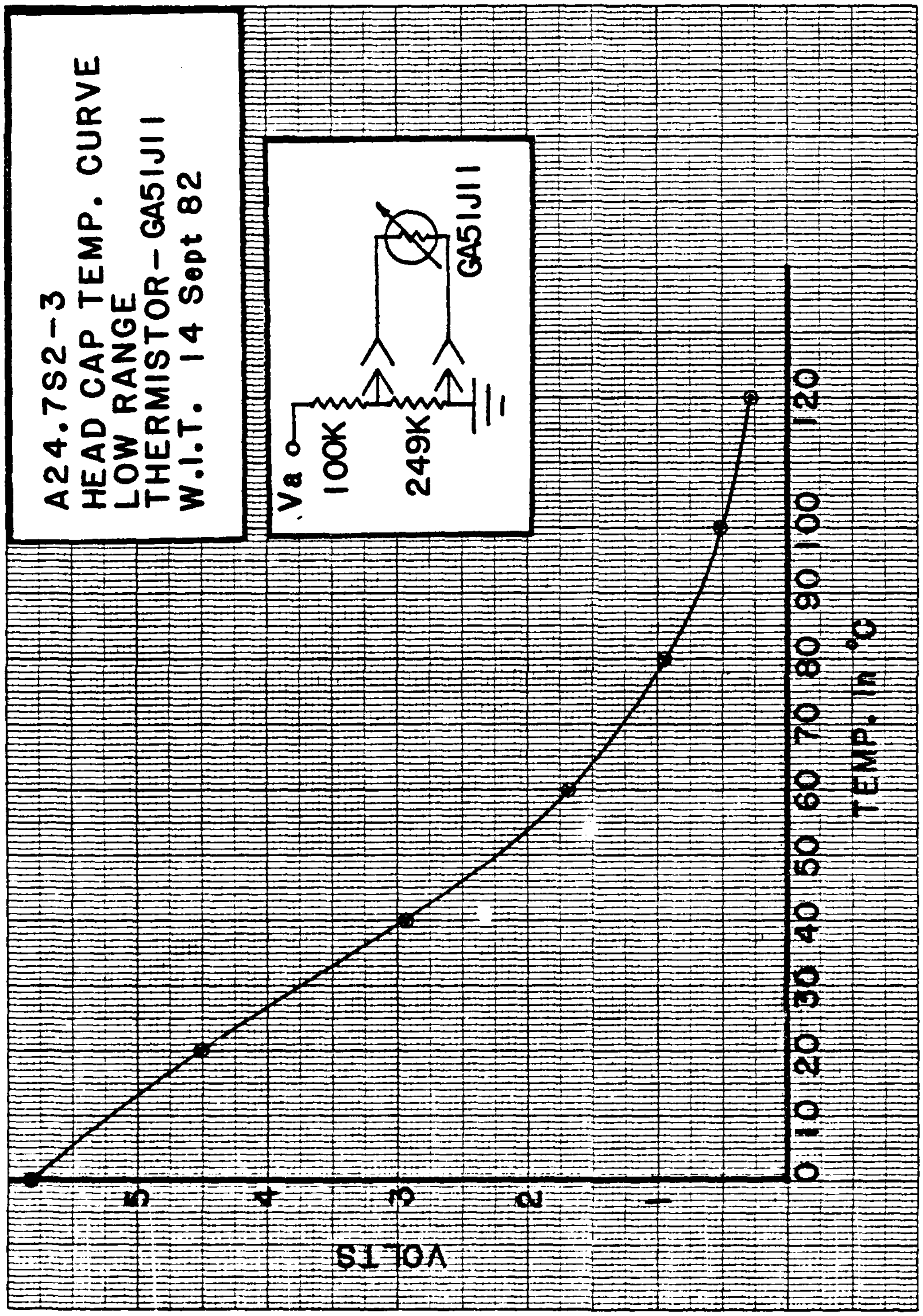
HEADCAP HEAT SINK CONFIGURATION

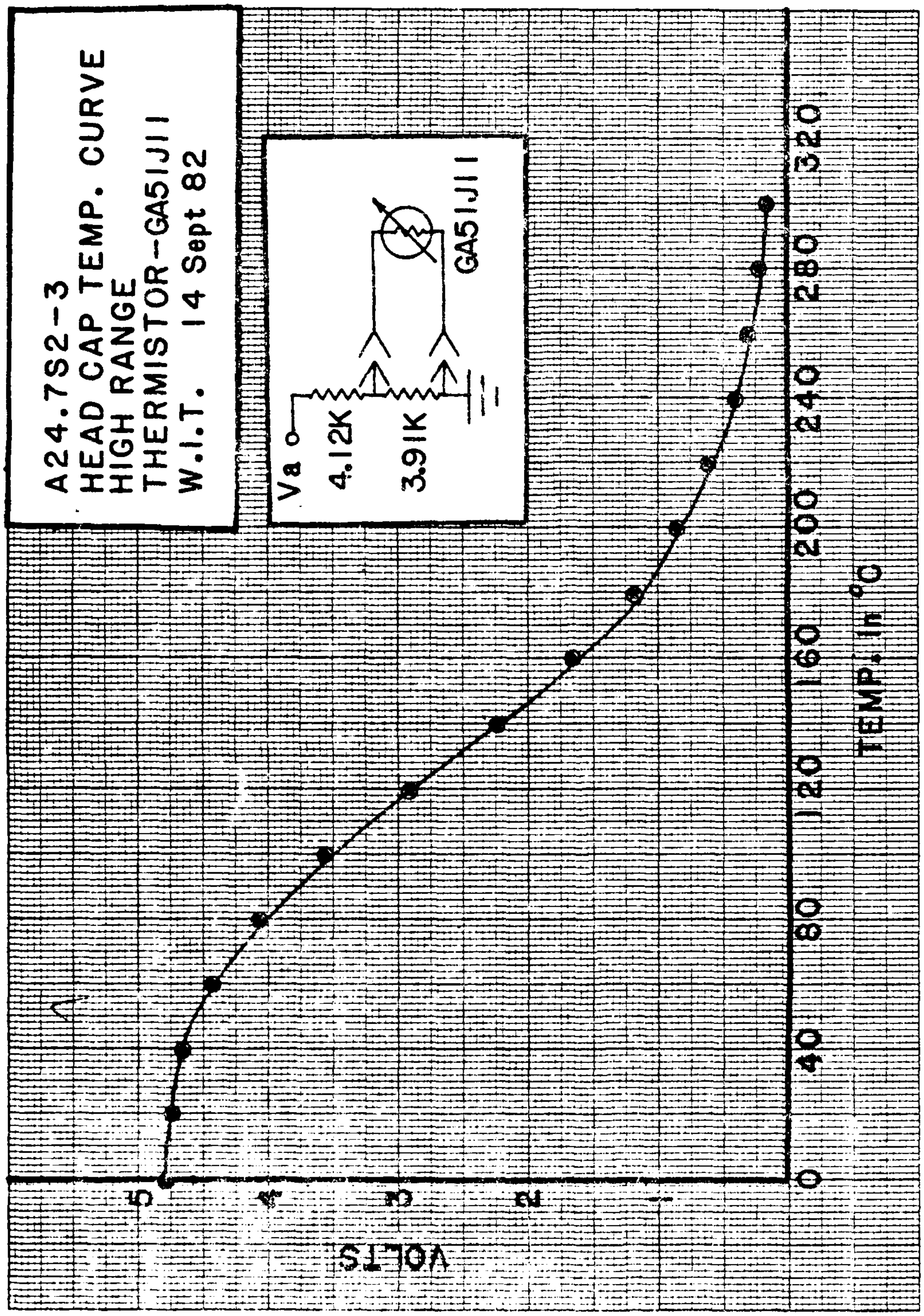
:mistor Map



E :
1-38 are High Temp.
-20 are Low Temp.
hermistors GA51J11

● Dome Thermistors
Δ Heat Sink thermistors


A24.7S2-3
HEAD CAP TEMP. CURVE
LOW RANGE
THERMISTOR-GA51J11
W.I.T. 14 Sept 82
Va
100K
249K
GA51J11
VOLTS
5
4
3
2
1
0 10 20 30 40 50 60 70 80 90 100 120
TEMP. In °C



A24.7S2-3
HEAD CAP TEMP. CURVE
HIGH RANGE
THERMISTOR—GA51J11
W.I.T. 14 Sept 82
Va
4.12K
3.91K
GA51J11
0
40
80
120
160
200
240
280
320
TEMP. In °C
5
4
3
2
1
VOLTS

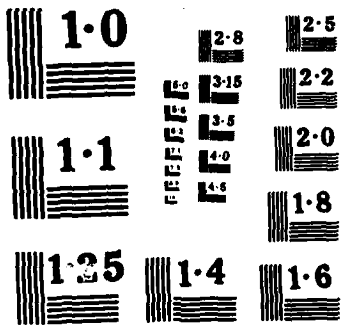
Appendix B

Payload Thermistor Locations and V-T Curves

AD-A156 075 DESIGN OF SCIENTIFIC PAYLOADS AND COMPONENTS(U) 2/2
WENTWORTH INST OF TECH BOSTON MA R W EBACHER ET AL.
16 SEP 83 AFGL-TR-83-0309 F19628-79-C-0103

UNCLASSIFIED F/G 22/1 NL

END
FILMED
DTIC



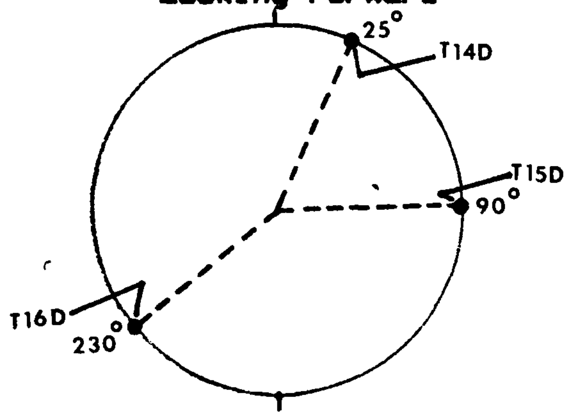
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

SPICE-2 (A24-7S2-3)

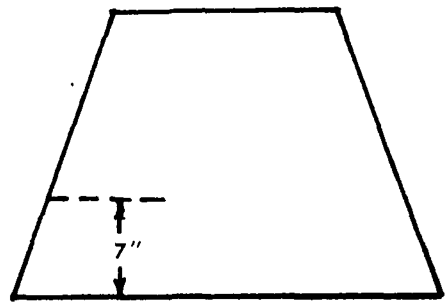
E.O.F. Report

<u>Thermistor Location on Nose Cone Skin T14D - T16D</u> :

Looking Forward



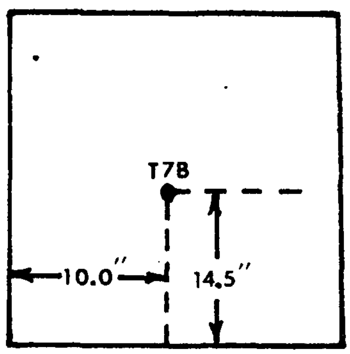
Side View



<u>Weldment Skin Temperature</u> :

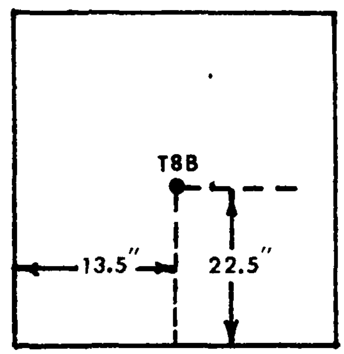
Side Views

Forward



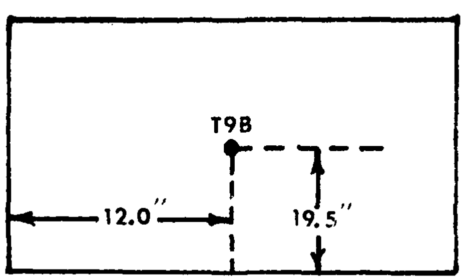
Brake Panel

Forward



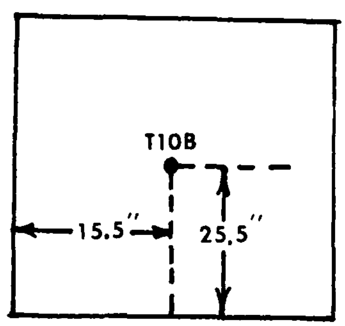
Drive Panel

Forward



W.I.T. Access

Forward



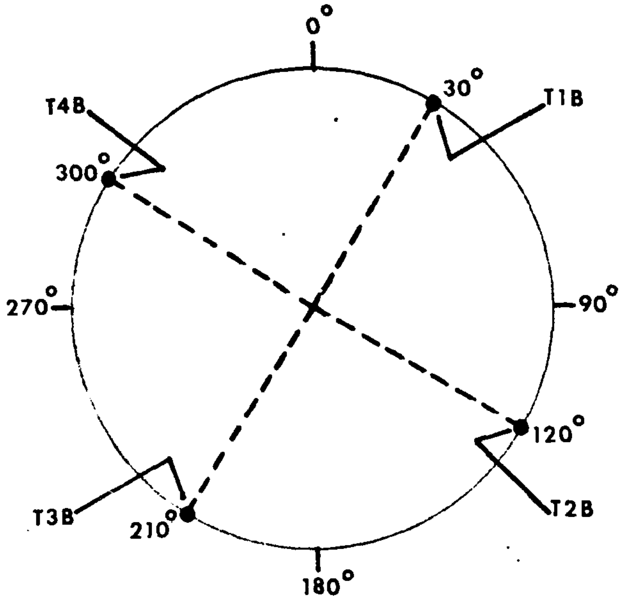
Sensor Door

SPICE-2 (A24.782-3)

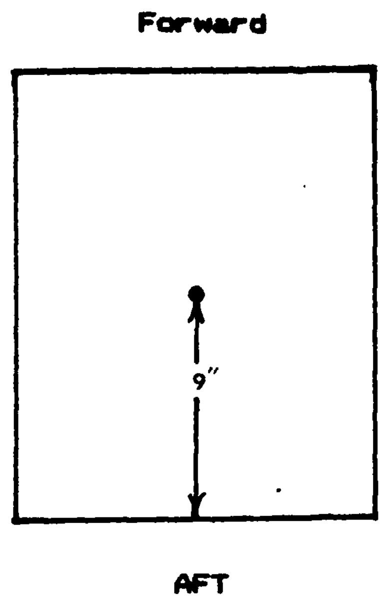
E.O.F. Report

Thermistor Locations on Aspect Skin

Looking Forward

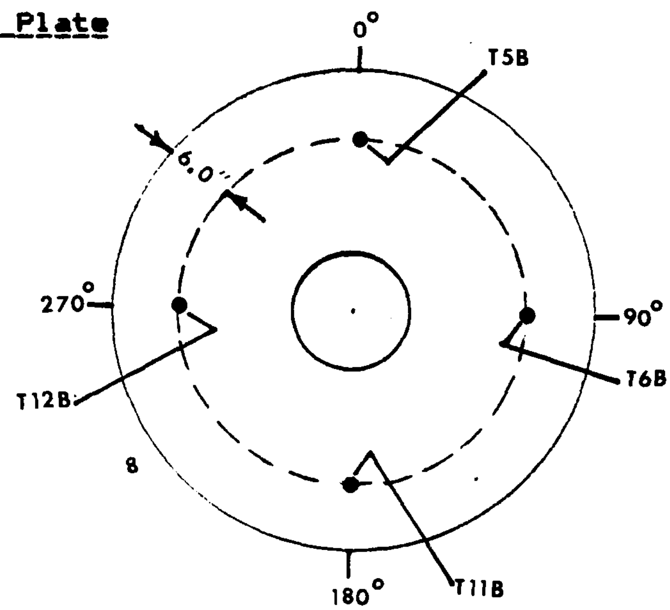


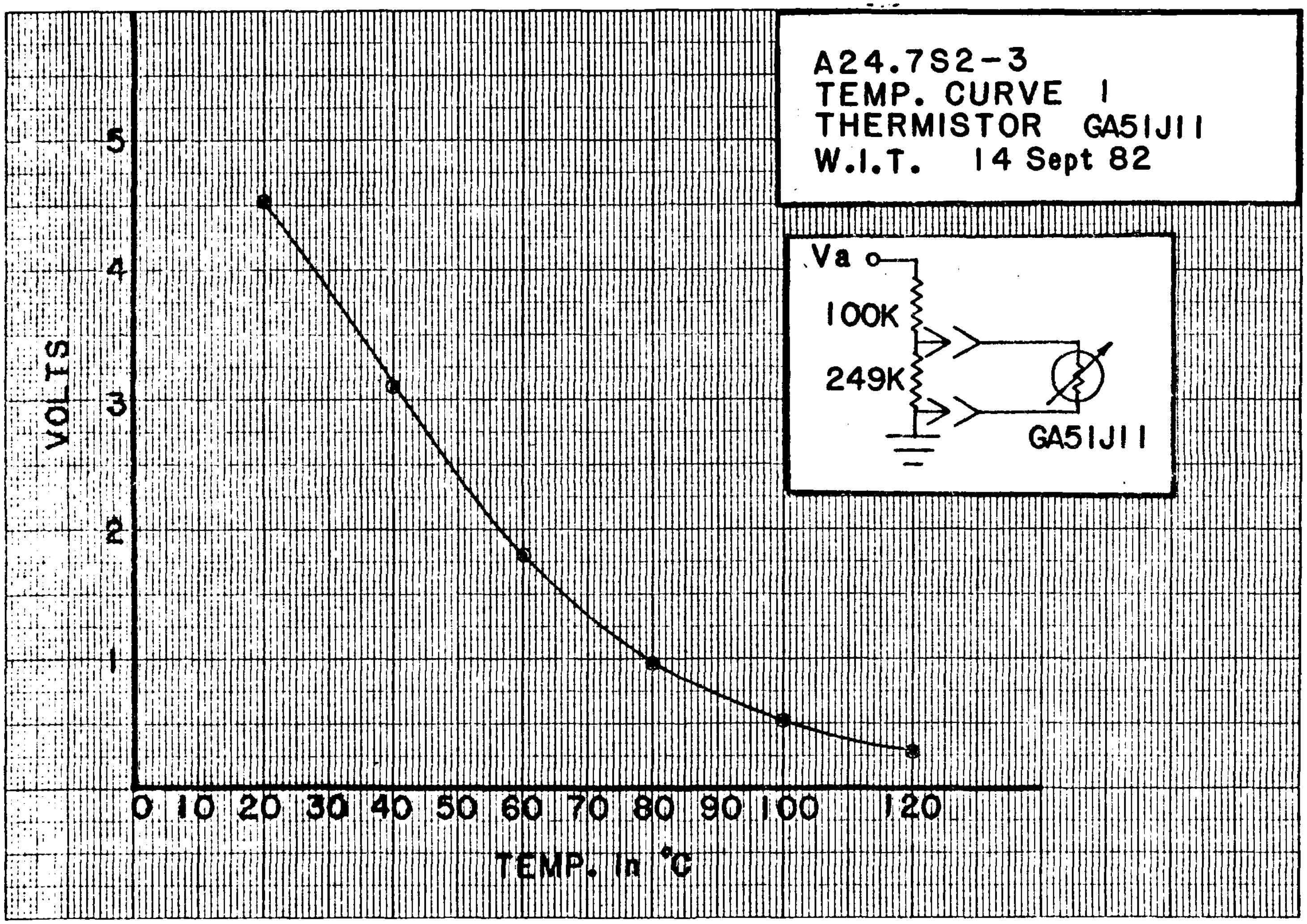
Side View of Aspect Can

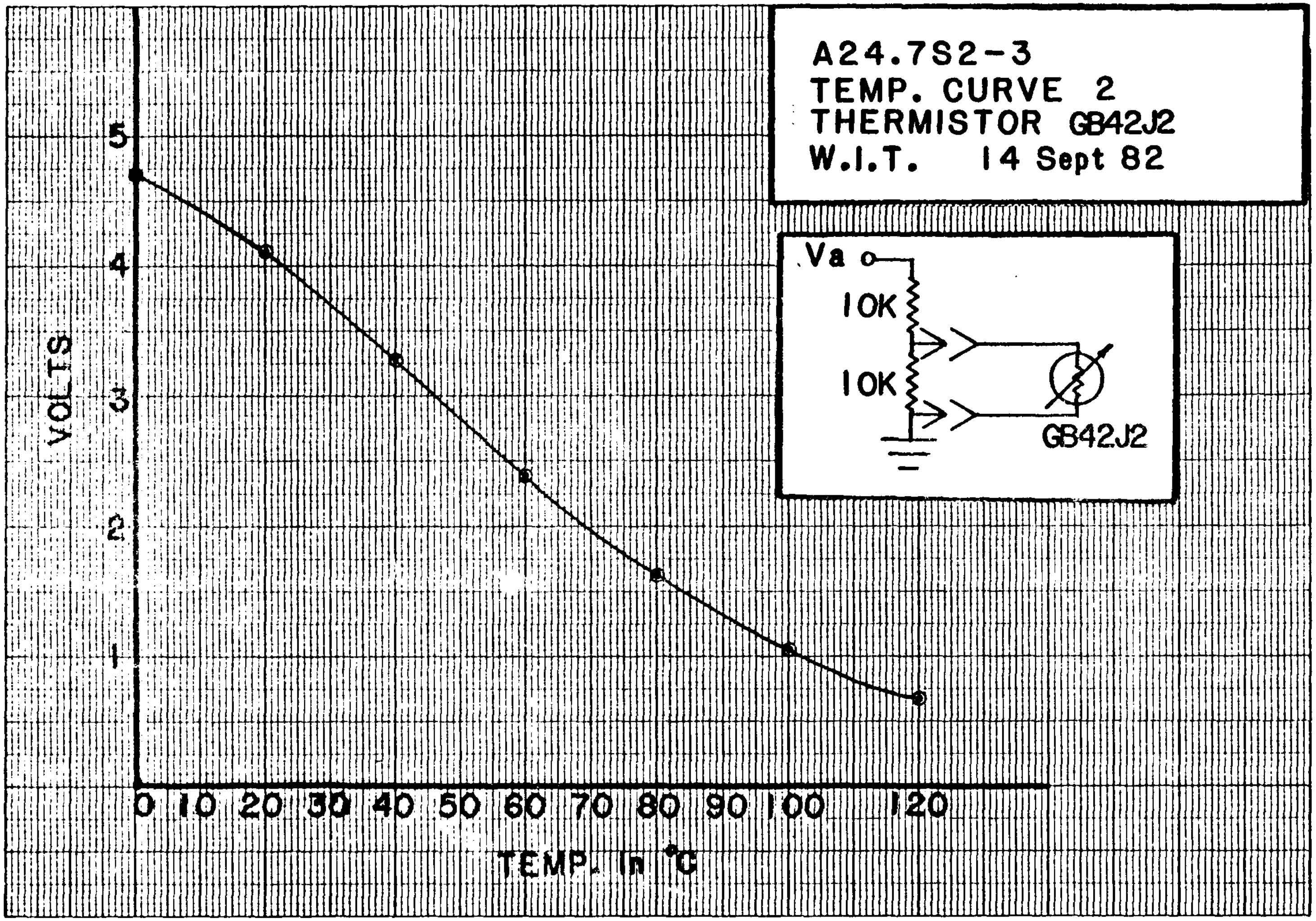


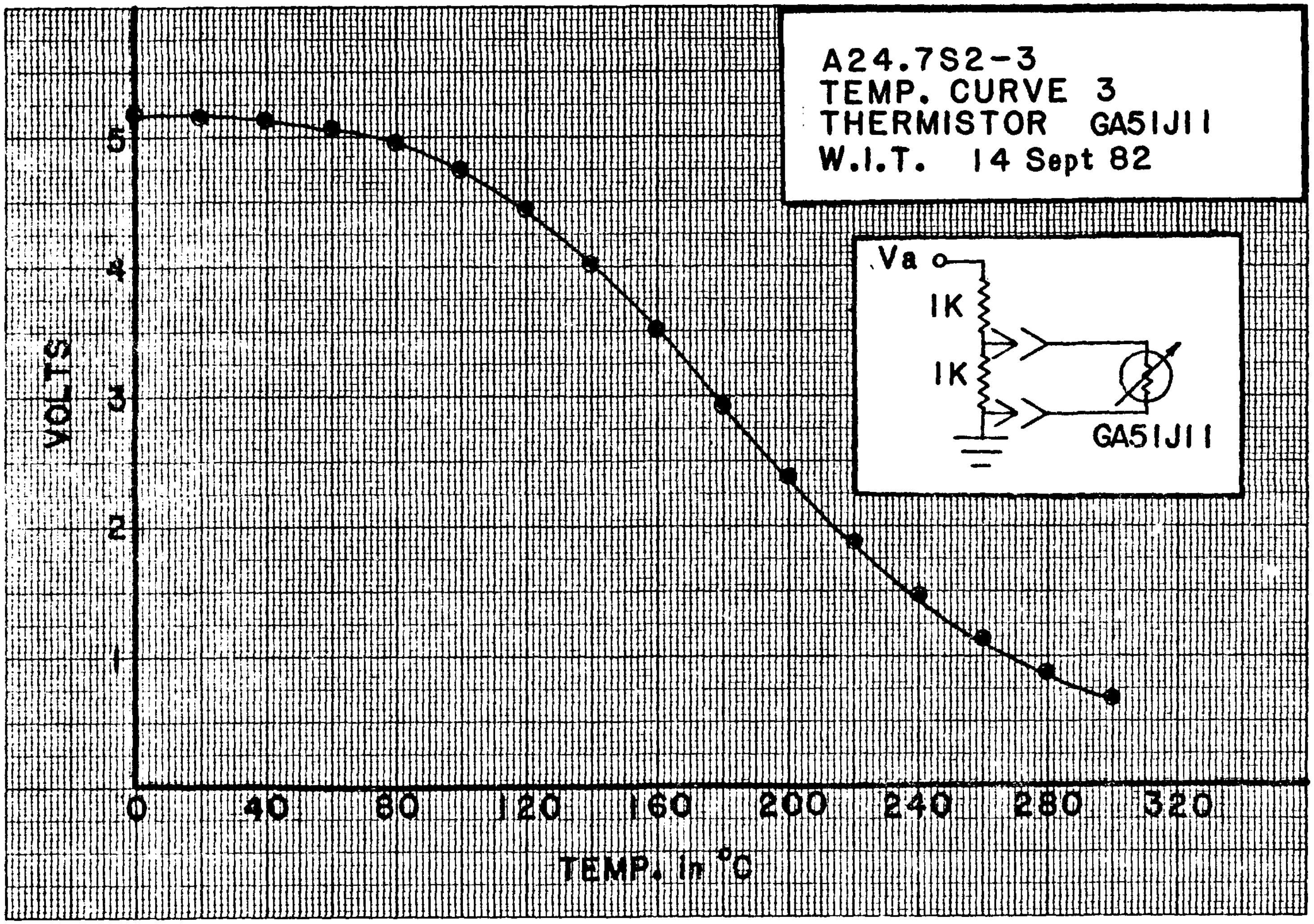
Thermistor Location on End Plate

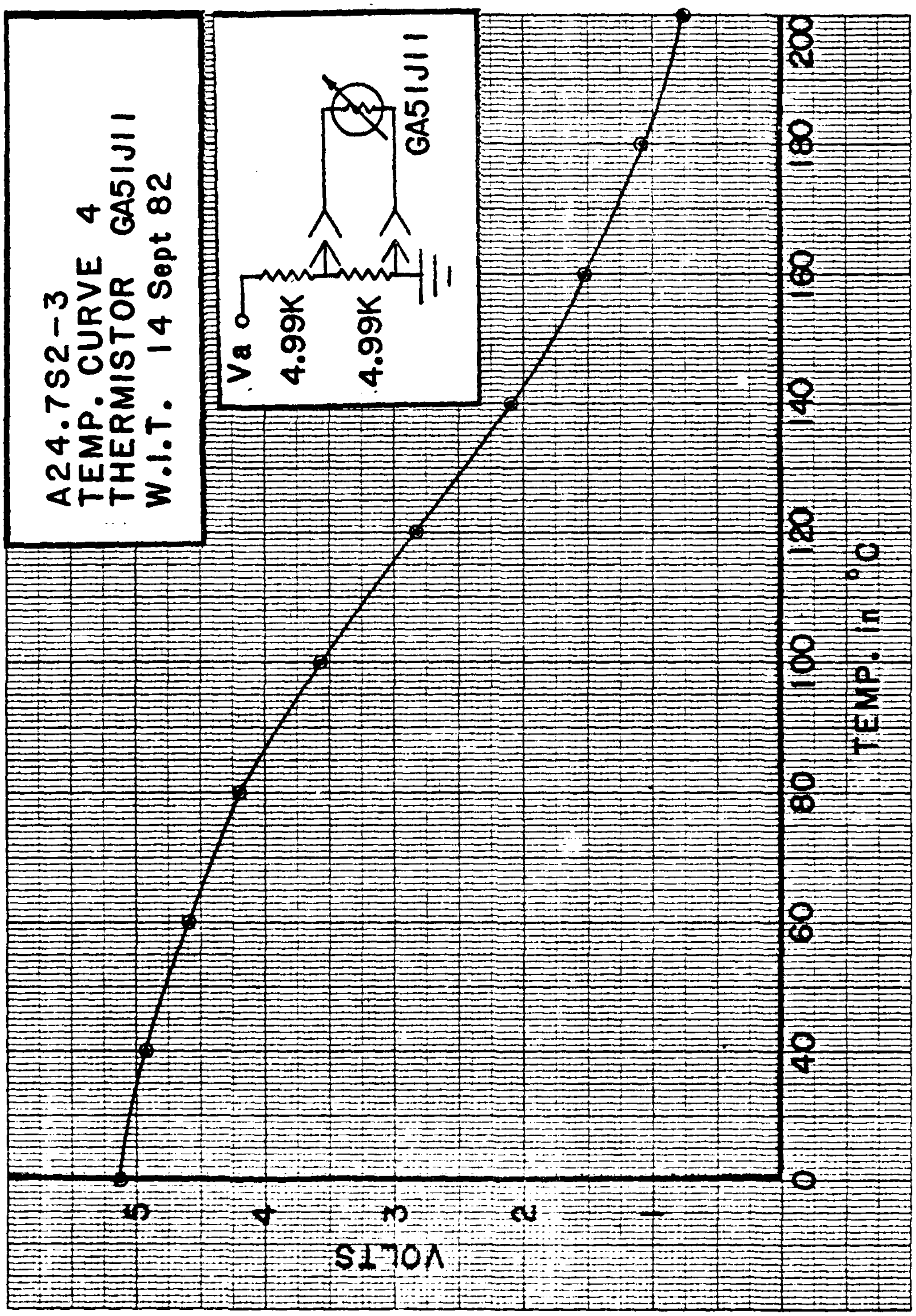
Looking Forward

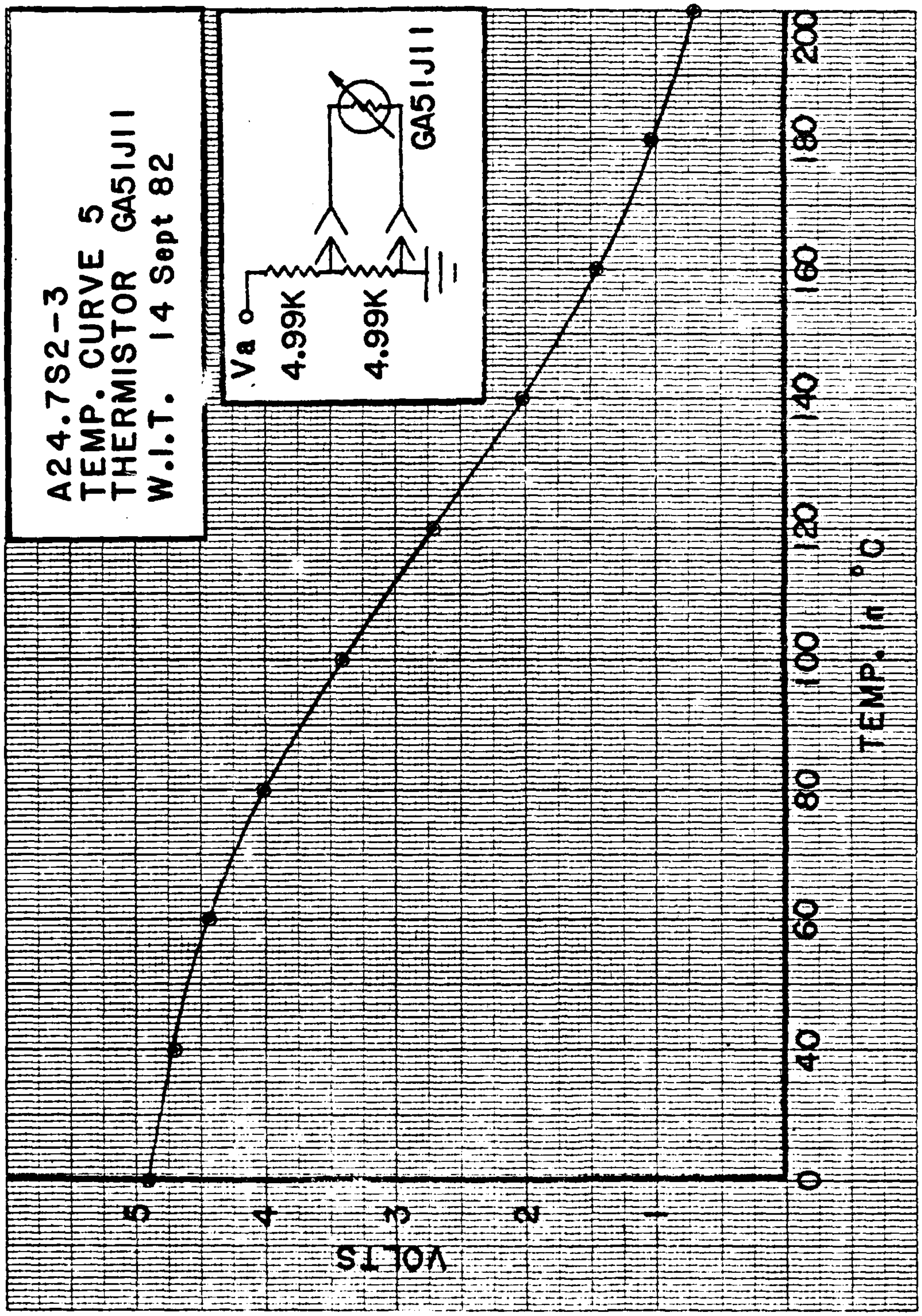


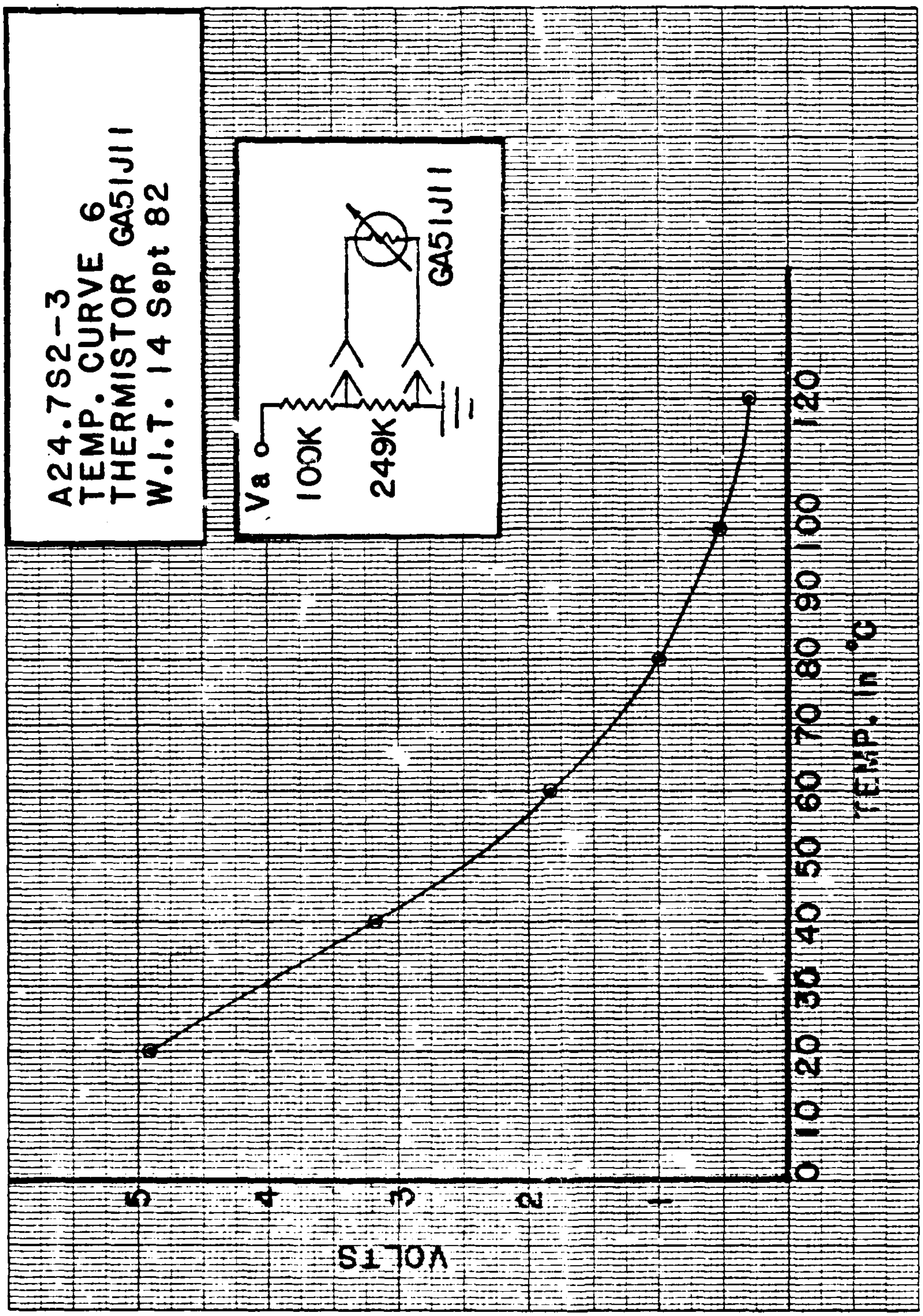

A24.7S2-3
TEMP. CURVE 1
THERMISTOR GA51J11
W.I.T. 14 Sept 82
Va
100K
249K
GA51J11
VOLTS
5
4
3
2
1
0 10 20 30 40 50 60 70 80 90 100 120
TEMP. In °C

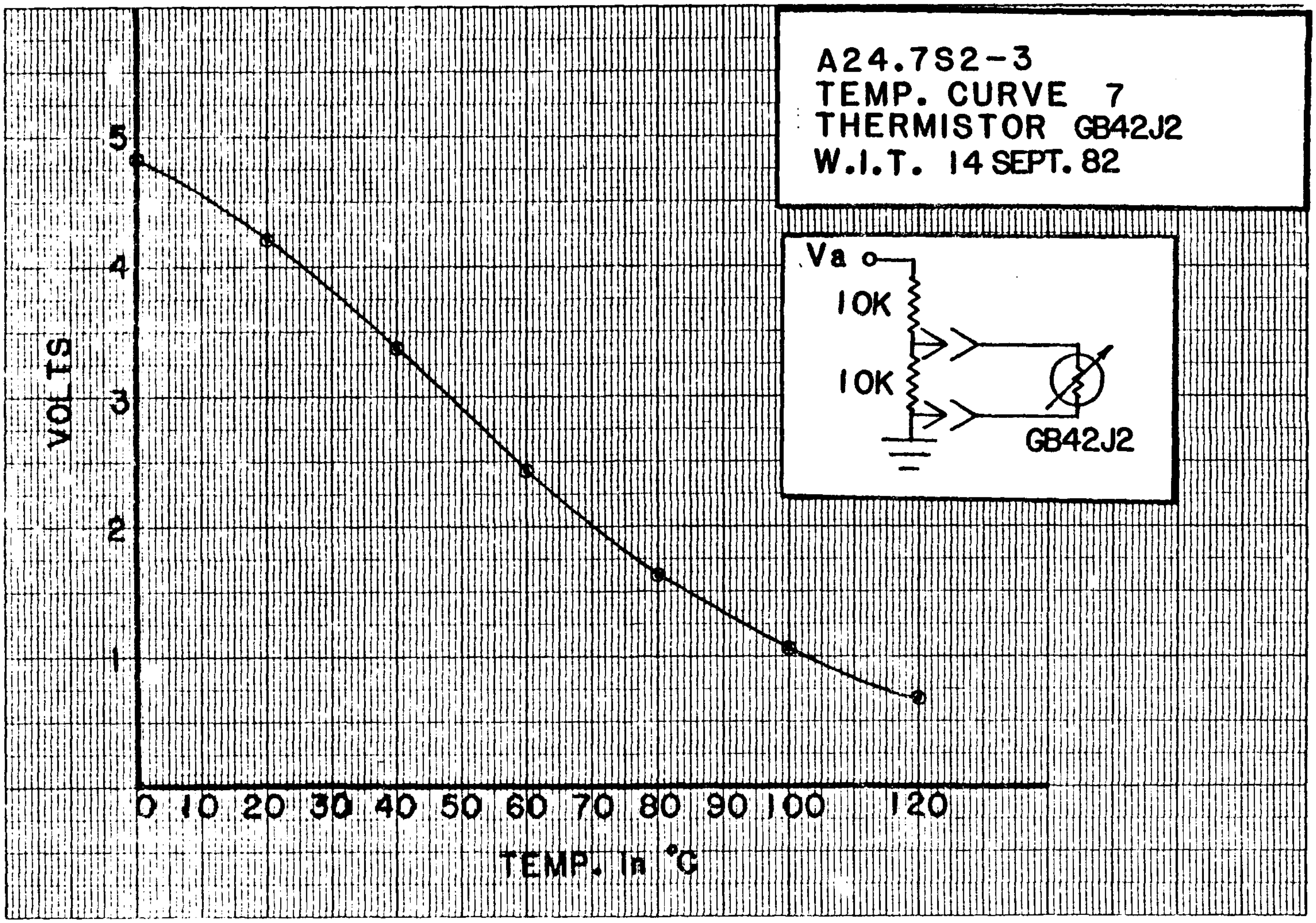

A24.7S2-3
TEMP. CURVE 2
THERMISTOR GB42J2
W.I.T. 14 Sept 82
Va
10K
10K
GB42J2
VOLTS
5
4
3
2
1
0 10 20 30 40 50 60 70 80 90 100 120
TEMP. In °C

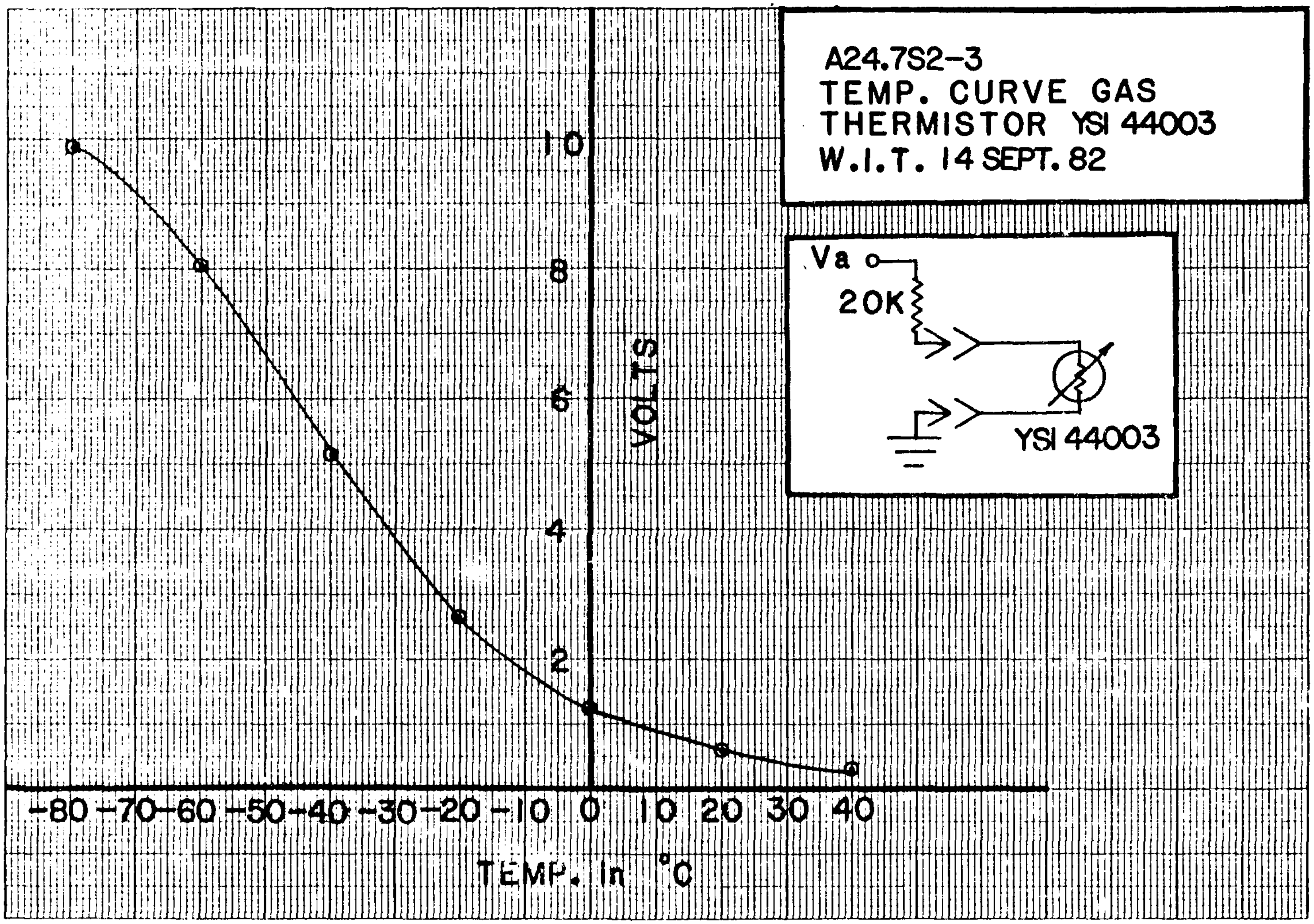

A24.7S2-3
TEMP. CURVE 3
THERMISTOR GA51J11
W.I.T. 14 Sept 82
Va
1K
1K
GA51J11
VOLTS
5
4
3
2
1
0
40
80
120
160
200
240
280
320
TEMP. in °C


A24.7S2-3
TEMP. CURVE 4
THERMISTOR GA51J11
W.I.T. 14 Sept 82
Va
4.99K
4.99K
GA51J11
VOLTS
5
4
3
2
1
0
40
60
80
100
120
140
160
180
200
TEMP. in °C


A24.7S2-3
TEMP. CURVE 5
THERMISTOR GA51J11
W.I.T. 14 Sept 82
Va
4.99K
4.99K
GA51J11
VOLTS
5
4
3
2
1
0
20
40
60
80
100
120
140
160
180
200
TEMP. in °C


A24.7S2-3
TEMP. CURVE 6
THERMISTOR GA51J11
W.I.T. 14 Sept 82
Va
100K
249K
GA51J11
VOLTS
5
4
3
2
1
0 10 20 30 40 50 60 70 80 90 100 120
TEMP. in °C


A24.7S2-3
TEMP. CURVE 7
THERMISTOR GB42J2
W.I.T. 14 SEPT. 82
Va
10K
10K
GB42J2
VOLTS
1
2
3
4
5
0 10 20 30 40 50 60 70 80 90 100 120
TEMP. In °C


A24.7S2-3
TEMP. CURVE GAS
THERMISTOR YSI 44003
W.I.T. 14 SEPT. 82
Va
20K
YSI 44003
VOLTS
10
8
6
4
2
-80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40
TEMP. In °C

Appendix C

Manufacturer's Calibration Record

Customer WENTWORTH
Customer #
Quote # 5E-72

SMI SENSO-METRICS
7775 Kester Avenue (213) 988-6070
Van Nuys, Ca. 91405 TWX 910-495-1715

Model # SP-973B
Serial # 1B550 (265)
Range 0-2 PSIA

Final Calibration Sheet

TEST PARAMETER	TEST VALUE	UNITS	ACCEPT	REJECT
Examine Product				
Input Voltage	+28.00	VDC		
Input Current	+14.36	MaDC		
Input Resistance	—	Ohms		
Output Resistance	—	Ohms		
Insulation	∞	Megohms		
Isolation	∞	Megohms		
Linearity	—	MVDC		
Hysteresis	—	MVDC		
Repeatability	—	MVDC		
Combined L,H&R	<±.30	BFSL		
Zero Temperature Shift	<±2.0	%/100°F		
Span Temperature Shift	<±2.0	%/100°F		

TEMPERATURE DATA:

PSI	AMB.	°F	°F	°F	AMB.			
0						MVDC		
FS						MVDC		
Span						MVDC		

CALIBRATION DATA:

PSIA	Incr.	Decr.	Incr.	S.L.	Dev.			
0	-90	-96				MVDC		
.4	894	891		895	4	MVDC		
.8	1852	1842		1881	39	MVDC		
1.2	2835	2832		2867	35mv	MVDC		
1.6	3842	3843		3853	11mv	MVDC		
2.0	4839	—				MVDC		
Span	4929	—				MVDC		

WIRING:

Input	+ A	- D
Output	+ B	- C

Tested by KDE Date 2-18-81

Accepted by Date

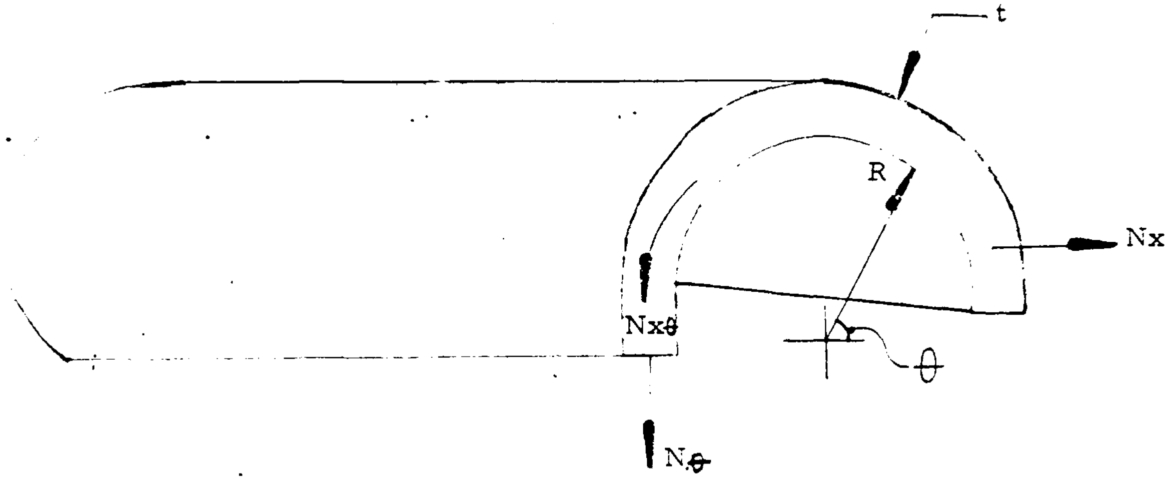
CALCULATION SHEET

D. Berkowitz DATE 8/80 CHECKER DATE

DEFINITION OF THIN CYLINDRICAL SHELL PRIMARY QUANTITIES

A.F. AURORAL "E" JOB NO. A10.903

SHEET NO. OF



R - Radius of Cylinder (use inside radius) (in)

t - Thickness of Wall (in)

Nx - Meridional Normal Force (lbs/in)

Nθ - Circumfrential Normal Force (lbs/in)

Nxθ - Circumfrential Shear Force (lbs/in)

Sx - Meridional Normal Stress (lbs/in^2)

Sθ - Circumfrential Normal Stress (lbs/in^2)

Sxθ - Circumfrential Shear Stress (lbs/in^2)

orth
e of Technology

CALCULATION SHEET

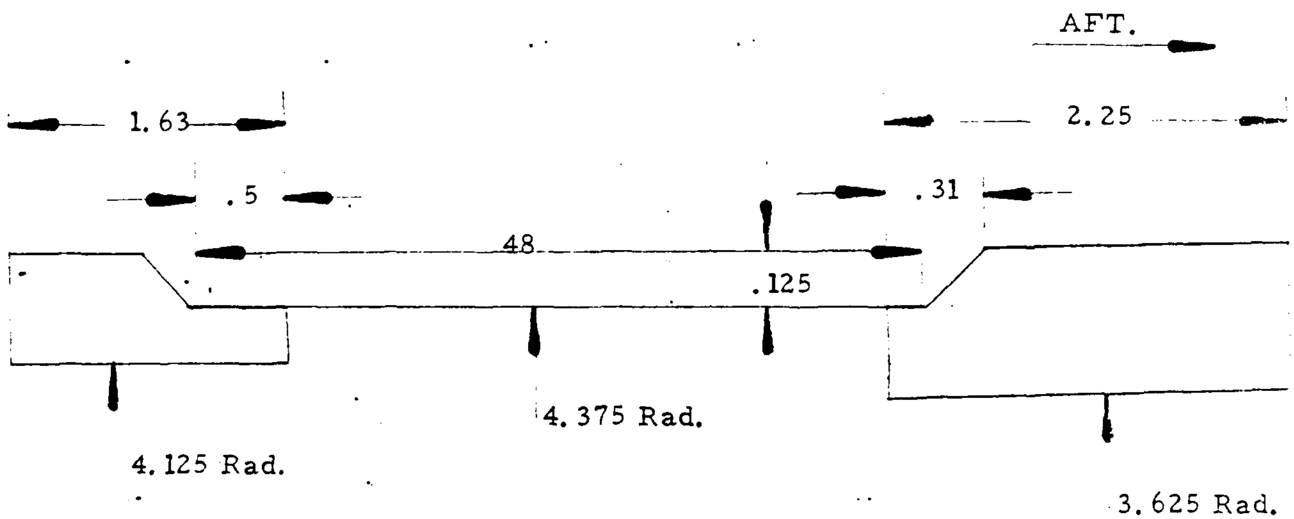
D. Berkowitz DATE 8/80 CHECKER DATE

A. F. AURORAL "E"

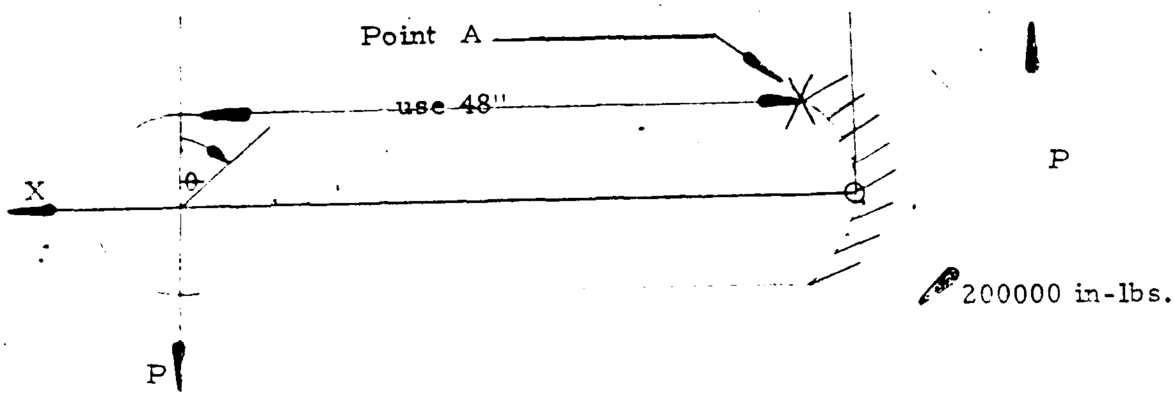
SKIN WELDMENT AND REQUIRED LOADING CONDITIONS JOB NO. A10. 903

SHEET NO. OF

REF. NO. D-11402



Required Loading Condition (Ref. E. LeBlanc)



Establish P To Produce 200000 in-lbs. As Shown.

$$P = \frac{200000}{48} = 4167.\ \text{lbs.}$$

MATERIAL - ALUMINUM #6061

MODULUS OF ELASTICITY 10×10^6 lbs/in^2

CONDITION	YIELD
T0	8000 lb/in^2
T4	21000 lb/in^2
T6	40000 lb/in^2

(Ref. E. LeBlanc)

DESCRIPTION OF ANALYSIS

1. The weldment can be considered structurally as a thin cylindrical shell, since the ratio of the wall thickness to the mean radius is $.125 \div 4.375 = .028$.

2. For the loading ., a primary solution for the stress field was obtained

   The circumfrential shear stress field was found to be sinusoidal in the circumfrential direction with maximum values at 90° to the direction of the applied load and is independent of the axial shell coordinate.

3. The meridional normal stress field was found to have a co-sine distribution in the circumfrential direction with peak values at 0° to the applied load and is linear in the axial shell coordinate.

CONCLUSION

The peak weldment circumfrential shear stress was calculated to be 2425 lbs/in^2

The peak weldment meridional normal stress was calculated to be 28000 lbs/in^2

The stress level for the peak meridional normal stress is in excess of the yield point as specified by the T4 material condition Associated with this peak meridional normal stress is a shear stress of 14000 lbs/in^2 from stress tensor calculations.

Wentworth
Institute of Technology

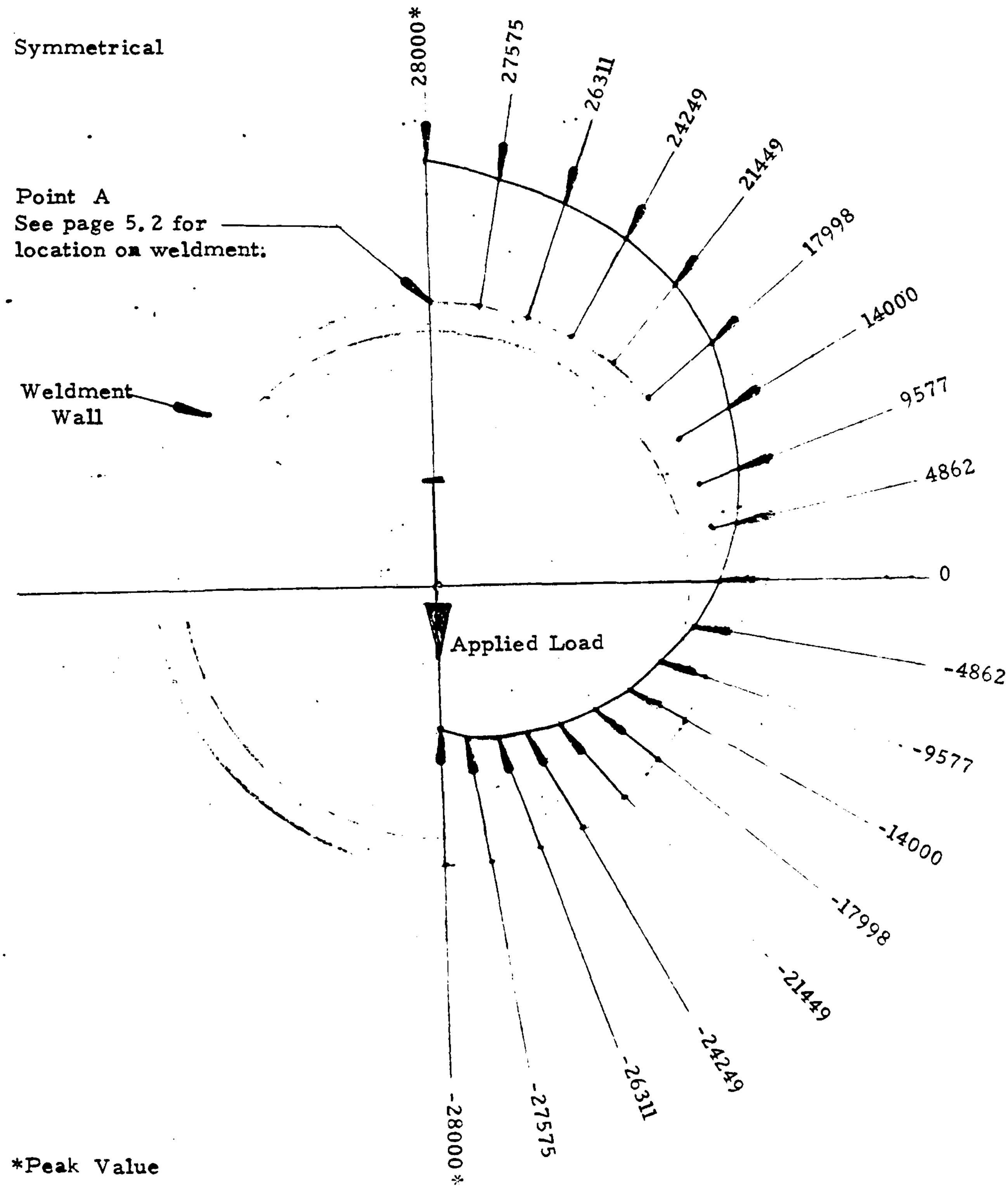
CALCULATION SHEET

DESIGNER D. Berkowitz DATE 8/80 CHECKER ______ DATE ______

A. F. AURORAL "E"

TITLE Sx - MERIDIONAL NORMAL STRESS PLOT (LB/IN^2) JOB NO. A10.903

SUBJECT (WORST CROSS SECTION) SHEET NO. ______ OF ______



*Peak Value

Wentworth
Institute of Technology

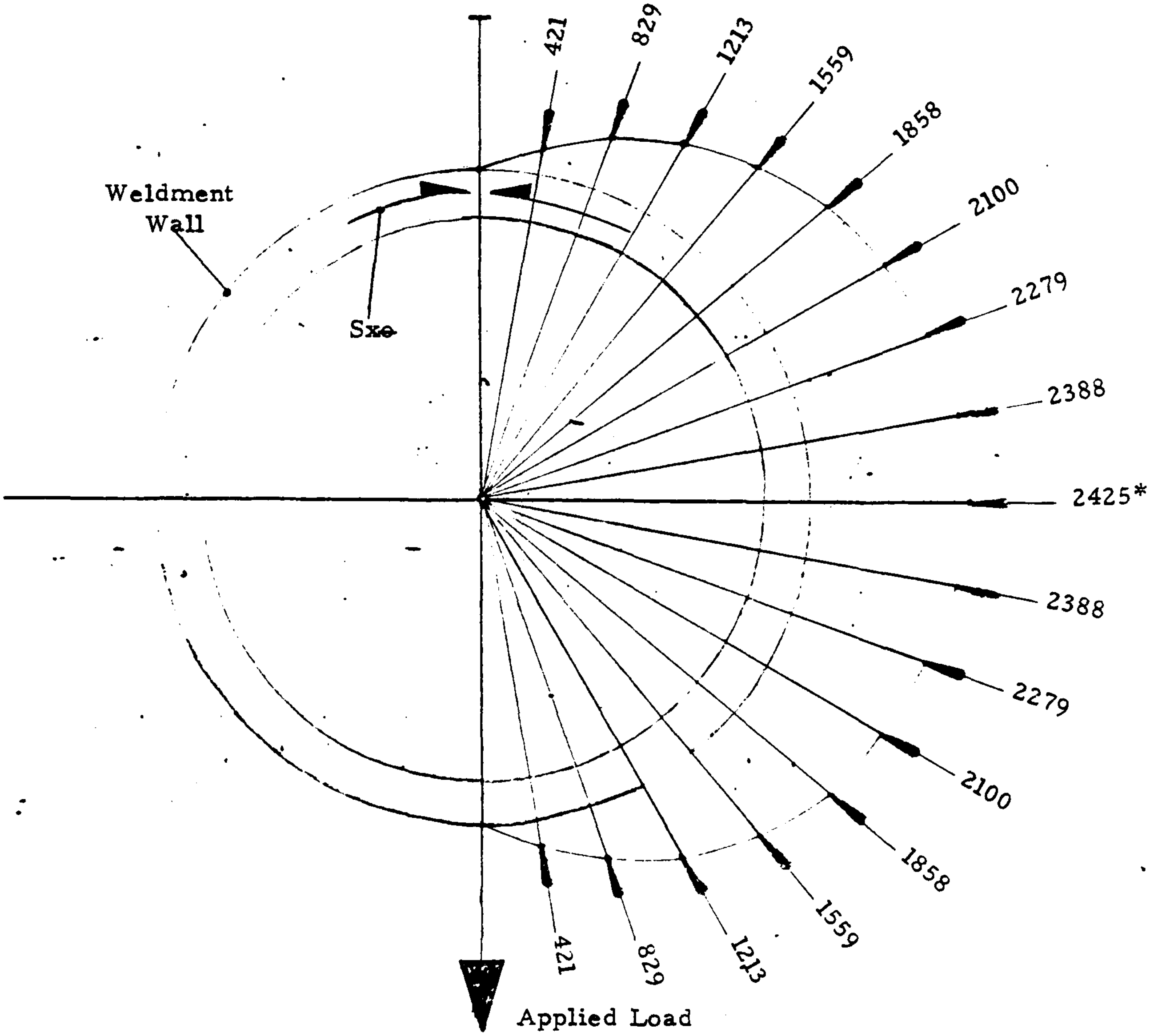
CALCULATION SHEET

DESIGNER D. Berkowitz DATE 8/80 CHECKER ____ DATE ____

TITLE ~~Sxe~~ - CIRCUMFRENTIAL SHEAR STRESS PLOT (LB/IN^2) A. F. AURORAL "E" JOB NO. A10.903

SUBJECT ____ SHEET NO. ____ OF ____

Both Sides Symmetrical



* Peak Value

INTRODUCTION

This is a report of the stress conditions in the Skin Weldment (D-11402) resulting from the loading conditions shown on page 5.2.

WENTWORTH INSTITUTE
OF TECHNOLOGY

AIR FORCE PROJECT AURORAL "E" A10.903
CONTRACT F19628-79-C-0103

PAYLOAD SKIN WELDMENT
SHELL STRESSES

BY: [illegible]

DATE: August, 1980

Humphrey Inc.
ELECTRO-MECHANICAL INSTRUMENTS

ACCELEROMETER INSPECTION RECORD

Date Shipped 6-21-77
Reference ______ (Customer's Specs., etc.)
Inspected by J. L. Thornton

Model No. LA45-0118-1
Serial No. #1120
Cust., No. ______ Rev. ______
New ✓ Repair ______

CHECK LIST	
ITEMS	RESULTS
1. HIGH POTENTIAL	—
2. INSULATION RESISTANCE	∞
3. POTENTIOMETER RESISTANCE	4970 Ω
4. POTENTIOMETER NOISE	5 Ω
5. DAMPING RATIO	ok
6. SEALING	ok
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	

REMARKS:

CALIBRATION RECORD

RANGE ±15G. ACCURACY ±1.5 %

NOMINAL INPUT G	NOMINAL OUTPUT RATIO	OUTPUT INCREASING G	OUTPUT DECREASING G
+15	1000	1000	1000
12	900	904	905
9	800	802	803
6	700	701	703
3	600	600	602
0	500	496	505
3	400	409	410
6	300	315	315
9	200	213	214
12	100	112	113
-15	0	012	012

SWITCH OPERATION

NOMINAL INPUT G	RUN #1 ON	RUN #1 OFF	LIMITS	RUN #2 ON	RUN #2 OFF

HI-1006 REV. 2-71

Humphrey Inc.
ELECTRO-MECHANICAL INSTRUMENTS

ACCELEROMETER INSPECTION RECORD

Date Shipped 6-21-77
Reference (Customer's Specs, etc.)
Inspected by J. L. Thornton

Model No LA45-0118-1
Serial No. H1119
Cust., No. Rev.
New ✓ Repair

CHECK LIST	
ITEMS	**RESULTS**
1. HIGH POTENTIAL	—
2. INSULATION RESISTANCE	∞
3. POTENTIOMETER RESISTANCE	4996 Ω
4. POTENTIOMETER NOISE	0
5. DAMPING RATIO	ok
6. SEALING	ok
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	

REMARKS:

CALIBRATION RECORD

RANGE ±15G ACCURACY ±1.5 %

NOMINAL INPUT G	NOMINAL OUTPUT RATIO	OUTPUT INCREASING Ω	OUTPUT DECREASING Ω
+15	1000	986	986
12	900	893	893
9	800	799	801
6	700	700	702
3	600	600	602
0	500	496	503
3	400	397	397
6	300	292	292
9	200	196	197
12	100	098	098
-15	0	000	000

SWITCH OPERATION

NOMINAL INPUT G	RUN #1 ON	RUN #1 OFF	LIMITS	RUN #2 ON	RUN #2 OFF

HI-1006 REV. 2-71

Humphrey Inc.
ELECTRO-MECHANICAL INSTRUMENTS

ACCELEROMETER INSPECTION RECORD

Date Shipped DEC 3 - 1980
Reference (Customer's Specs., etc.)
Inspected by Carole Sullivan

Model No. LA-45-0193-1
Serial No. H-85
Cust., No. ______ Rev. ______
New ✓ Repair ______

CHECK LIST	
ITEMS	RESULTS
1. HIGH POTENTIAL	———
2. INSULATION RESISTANCE	∞
3. POTENTIOMETER RESISTANCE	4940
4. POTENTIOMETER NOISE	5 Ω
5. DAMPING RATIO	O.K.
6. SEALING	O.K.
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	

REMARKS:

CALIBRATION RECORD

RANGE -5 to +30G ACCURACY ± 1.5 %

NOMINAL INPUT G	NOMINAL OUTPUT RATIO	OUTPUT INCREASING G	OUTPUT DECREASING G
+30.0	1000	1000	1000
26.5	900	911	911
23.0	800	810	810
19.5	700	703	702
16.0	600	606	600
12.5	500	501	501
9.0	400	404	407
5.5	300	305	308
2.0	200	202	208
8	143	148	155
1.5	100	105	107
-5.0	0	011	012

SWITCH OPERATION

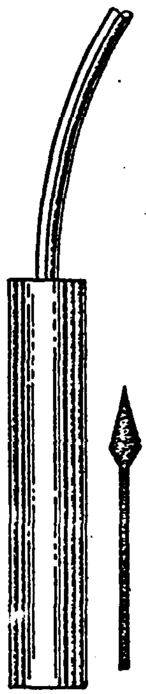
NOMINAL INPUT G	RUN #1 ON	RUN #1 OFF	LIMITS	RUN #2 ON	RUN #2 OFF

HELIFLUX®
MAGNETIC ASPECT SENSOR
TYPE RAM-5C SP

SERIAL Nº 31977

CALIBRATION DATA

FIELD IN MILLIGAUSS	OUTPUT SIGNAL IN VOLTS D C	
600	4.798	
550	4.605	
500	4.409	
450	4.209	
400	4.009	
350	3.807	
300	3.605	
250	3.403	
200	3.201	
150	2.999	
100	2.798	
50	2.598	
0	2.397	(BIAS LEVEL)
-50	2.196	
-100	1.995	
-150	1.792	
-200	1.589	
-250	1.386	
-300	1.181	
-350	0.978	
-400	0.775	
-450	0.574	
-500	0.374	
-550	+0.178	
-600	-0.016	



DIRECTION OF MAGNETIC FIELD FOR VOLTAGE SIGNALS ABOVE BIAS LEVEL

NOTE:
CALIBRATION MADE WITH A 100K OHM RESISTOR FROM SIGNAL OUTPUT TO NEGATIVE TERMINAL OF BATTERY SOURCE, AND A 100K OHM RESISTOR FROM BIAS OUTPUT TO NEGATIVE TERMINAL OF BATTERY SOURCE

SCHONSTEDT INSTRUMENT COMPANY
RESTON, VIRGINIA

MAY 1 RECD

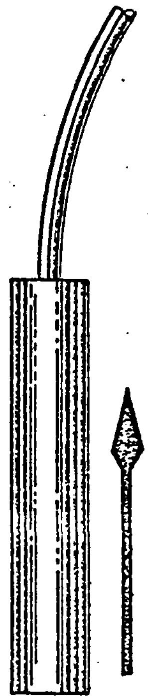
CALIBRATION MADE WITH BATTERY SUPPLY OF 28.0 VOLTS DATE 4/22/80

HELIFLUX®
MAGNETIC ASPECT SENSOR
TYPE RAM-5C SP

CALIBRATION DATA

SERIAL NO 31978

FIELD IN MILLIGAUSS	OUTPUT SIGNAL IN VOLTS D C	
600	4.804	
550	4.608	
500	4.409	
450	4.207	
400	4.004	
350	3.801	
300	3.598	
250	3.395	
200	3.193	
150	2.993	
100	2.793	
50	2.594	
0	2.396	(BIAS LEVEL)
-50	2.196	
-100	1.996	
-150	1.794	
-200	1.591	
-250	1.386	
-300	1.181	
-350	0.975	
-400	0.769	
-450	0.565	
-500	0.365	
-550	+0.167	
-600	-0.024	



DIRECTION OF MAGNETIC FIELD FOR VOLTAGE SIGNALS ABOVE BIAS LEVEL

NOTE:
CALIBRATION MADE WITH A 100K OHM RESISTOR FROM SIGNAL OUTPUT TO NEGATIVE TERMINAL OF BATTERY SOURCE, AND A 100K OHM RESISTOR FROM BIAS OUTPUT TO NEGATIVE TERMINAL OF BATTERY SOURCE

SCHONSTEDT INSTRUMENT COMPANY
RESTON, VIRGINIA

MAY 1

CALIBRATION MADE WITH BATTERY SUPPLY OF 28.0 VOLTS DATE 4/22/80

(See Reference #1)

$P = 4167.$ lbs.

$R = 4.375$ in. $t = .125$ in

$N_{x\theta} = \frac{P}{\pi R} \sin\theta = 303 \sin\theta$ lbs/in

$S_{x\theta} = \frac{N_{x\theta}}{t} = 2425 \sin\theta$ lbs/in^2

use

$N_x = \frac{P}{\pi R^2} (50 - X) \cos\theta = 70 (50 - X) \cos\theta$ lbs/in

$S_x = \frac{N_x}{t} = 560 (50 - X) \cos\theta$ lb/in^2

MAXIMUM SHELL STRESS QUANTITIES

$S_{x\theta}^{MAX} = 2425 \sin 90^\circ = 2425$ lbs/in^2

$S_x^{MAX} = 560 (50 - 0) \cos 0^\circ = 28000$ lbs/in^2

Wentworth
Institute of Technology

CALCULATION SHEET

DESIGNER D. Berkowitz DATE 8/80 CHECKER DATE

TITLE $Sx\theta$ - CIRCUMFRENTIAL SHEAR STRESS DATA A. F. AURORAL 'E' JOB NO. A10. 903

SUBJECT SHEET NO. OF

$$Sx\theta = 2425 \sin\theta \ \text{lbs/in}^2$$

$\theta°$	$\theta°$	$Sx\theta$ lb/in^2
0	180	0.
10	170	421.
20	160	829.
30	150	1213.
40	140	1559.
50	130	1858.
60	120	2100.
70	110	2279.
80	100	2388.
90		2425.

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CALCULATION SHEET

DESIGNER D. Berkowitz DATE 8/80 CHECKER ______ DATE ______

TITLE Sx - MERIDIONAL NORMAL STRESS DATA A.F. AURORAL "E" JOB NO. A10.903

SUBJECT ______ SHEET NO. ______ OF ______

$$Sx = 560\,(50 - X)\cos\theta \ \ \mathrm{lbs/in^2}$$

θ°	θ°	At X = 0 Sx lb/in^2	At X = 50 Sx lb/in^2
0	360	28000.	0.
10	350	27575.	
20	340	26311.	
30	330	24249.	
40	320	21449.	
50	310	17998.	
60	300	14000.	
70	290	9577.	
80	280	4862.	
90	270	0.	
100	260	-4862.	
110	250	-9577.	
120	240	-14000.	
130	230	-17998.	
140	220	-21449.	
150	210	-24249.	
160	200	-26311.	
170	190	-27575.	
180		-28000.	0.

REFERENCES

REFERENCE NO.

1. Structural Analysis of Shells
E. H. Baker, L. Kovalevsky and F. L. Rish, Authors
McGraw-Hill 1972

VACUUM VESSEL DESIGN

Prepared by: Edgar J. LeBlanc, Senior Mechanical Designer

Contract No. F19628-79-C-0103

PRELIMINARY CALCULATIONS FOR CONFIGURATION OF FIBERGLASS SUPPORT CYLINDERS

1. Thermal conductivity as calculated from curves in report "Properties of Filamentary Reinforced Composites at Cryogenic Temperatures", by M.B. Kaser. This report was published in 1975, by Composite Reliability, ASTM STP 580, American Society for Testing Materials, pages 586 - 611.

From a Curve (1a, Fig.5) for the material (S-994 glass roving and E-787 resin, EPON 828/EPON 1031) the following values were determined.

At $20^{o}K$ 0.250 W/M - ^{o}K = 0.00635 W/in. - ^{o}K

At $75^{o}K$ 0.408 W/M - ^{o}K = 0.01036 W/in. - ^{o}K

At $200^{o}K$ 0.634 W/M - ^{o}K = 0.01610 W/in. - ^{o}K

At $300^{o}K$ 0.873 W/M - ^{o}K - 0.02217 W/in. - ^{o}K

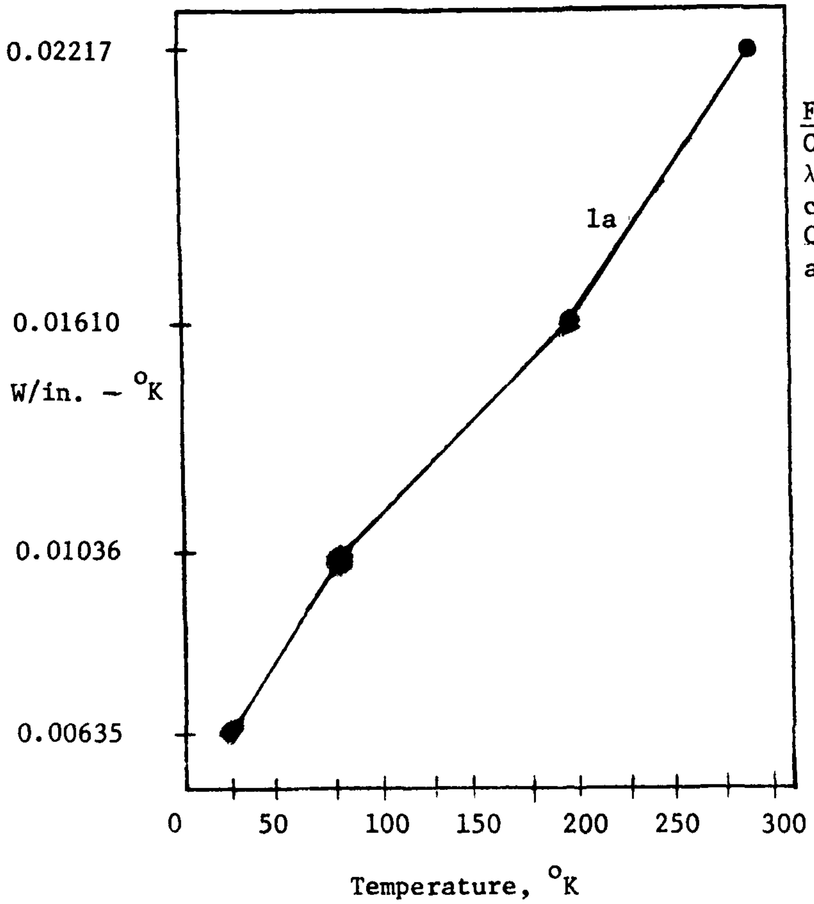
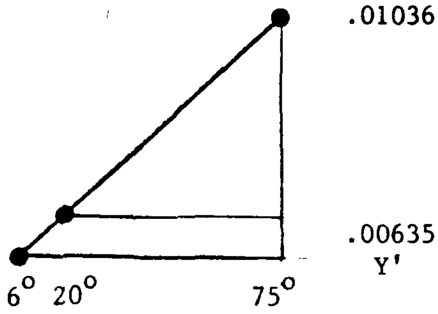


Fig. 5 - Thermal Conductivities, λ, of glass-epoxy composites at Cryogenic temperature.

1a. <u>To extend the lower end of the curve to 6^oK</u>

$$\frac{.01036 - .00635}{75 - 20} = \frac{.00635 - Y'}{20 - 6}$$

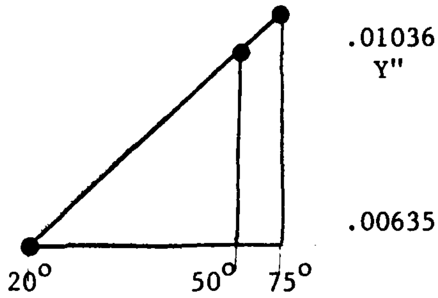
$Y' = .00533$ W/in. - ^oK at 6^oK



1b. <u>To obtain value of W/in. - ^oK at 50^oK</u>

$$\frac{.01036 - .00635}{75 - 20} = \frac{.01036 - Y''}{75 - 50}$$

$Y'' = .00854$ W/in. - ^oK at 50^oK



1c. <u>To find ave. λ between 6^oK and 50^oK</u>

$$\lambda_{ave} = \frac{(.00854 + .00533)}{2} = .00694 \text{ W/in. - } ^oK$$

1d. <u>To find ave. λ between 50^oK and 300^oK</u>

$$\lambda_{ave} = \left[\frac{(.01036 + .00854)}{2}(75 - 50) + \frac{(.01610 + .01036}{2}(200 - 75) + \frac{(.02217 + .01610)}{2}(300 - 200)\right] \div (300 - 50)$$

$$\lambda_{ave} = .01521 \text{ W/in. - } ^oK$$

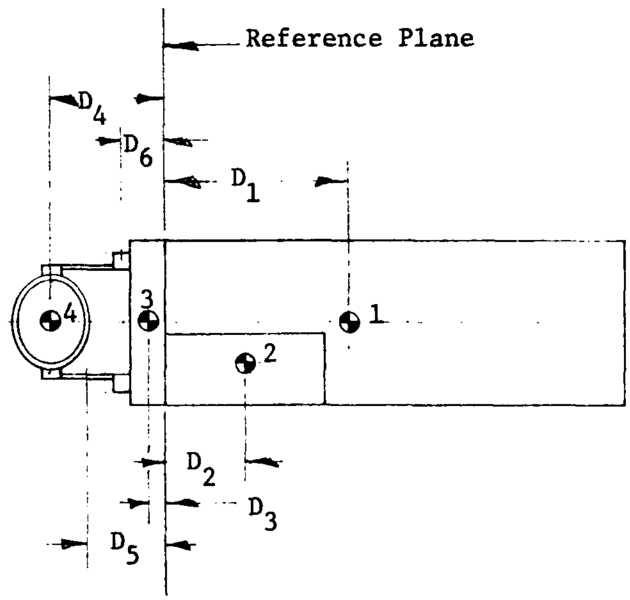
1e. Typical strength figures for Glass-Epoxy Laminates:

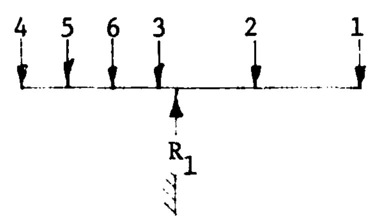
Source	Tensile Strength	Flexural Strength	Shear Strength	Modulus of Elasticity
1. Machine Design Materials Reference Flat Stock - G10	45000 psi 45000 psi	55000 psi 45000 psi	19000 psi	
2. NVF Co. Filament Wound Cylinder Using E-Glass & EA 826 Adhesive	$\approx$ 75000 psi	$\approx$ 65000 psi		5×10^6 psi

2. <u>Weight/Moment Calculations</u>
(All weights considered to be concentrated at the C.G.)

2a. Telescope/Dewar with aft telescope interface as reference plane

	Item	Weight (lbs)	Distance (in)	Moment (in.-lbs)
1.	Telescope	500	+ 35	- 17500
2.	Experiment	60	+ 17.25	- 1035
3.	Telescope Support Ring	45.8	- .50	+ 23
4.	Dewar with He	67.45	- 8.562	+ 578
5.	Dewar Support Cylinder	8.45	- 4.812	+ 41
6.	Sup. Cylinder Flange	2.54	- 1.125	+ 3
		R_1 = 684.24		M_1 = - 17890





3. <u>Inner Support Cylinder</u> (6^oK to 50^oK)

D_1 (O.D.) = 36.50"

D_2 (I.D.) = 36.25"

$A = \pi(18.250^2 - 18.125^2) = 14.284 \text{ in.}^2$

$$Z = \frac{I}{C} = \frac{\pi(D_1^4 - D_2^4)}{32\ D_1}$$

$$Z = \frac{\pi(36.50^4 - 36.25^4)}{32\ (36.50)}$$

$Z = 129.456 \text{ in.}^3$ (Section Modulus)

3a. <u>Length of inner support cylinder</u>

Using a maximum conductive heat loss of Q = .500 Watt

λ_{ave} = .00694 W/in.-^oK (6^oK to 50^oK) .

$$L = \frac{\lambda(T_2 - T_1)\ A}{Q}$$

$$L = \frac{.00694\ (50 - 6)\ \ (14.284)}{.500}$$

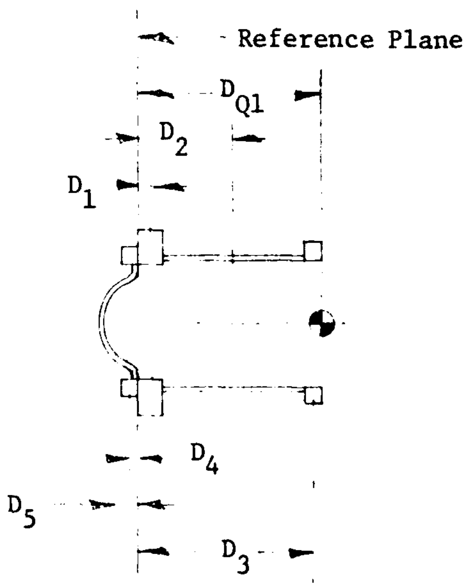
L = 8.724 in.

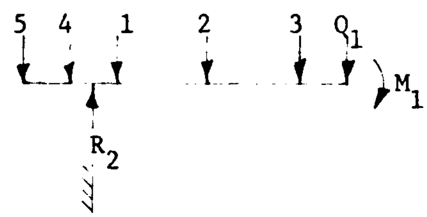
Weight = .0649 AL = .0649 (14.284) (8.724) = 8.09 lbs.

4. Weight/Moment Calculations
(All weights considered to be concentrated at the C.G.)

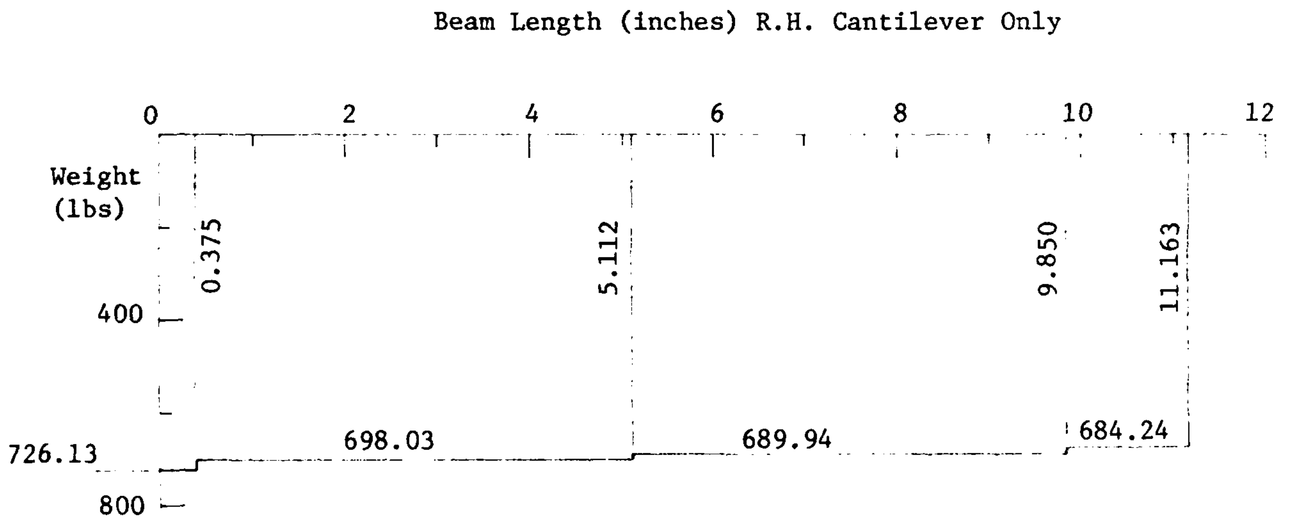
4a. Telescope/Dewar/Scope inner support cylinder/Rad shield aft with forward surface of $50^{o}K$ support ring as reference plane.

Item	Weight (lbs)	Distance (in)	Moment (in-lbs)
$Q_1 = R_1$	684.24	+ 11.163	- 7638
M_1			- 17890
1. $50^{o}K$ Support Ring	28.10	+ 0.375	- 11
2. Inner Support Cylinder	8.09	+ 5.112	- 41
3. Support Cylinder Flange	5.70	+ 9.850	- 56
4. Aft Rad Shield Flange	2.00	- 0.188	
5. Aft Rad Shield Cap	7.14	- 3.725	+ 27
	R_2 = 735.27		M_2 = - 25609

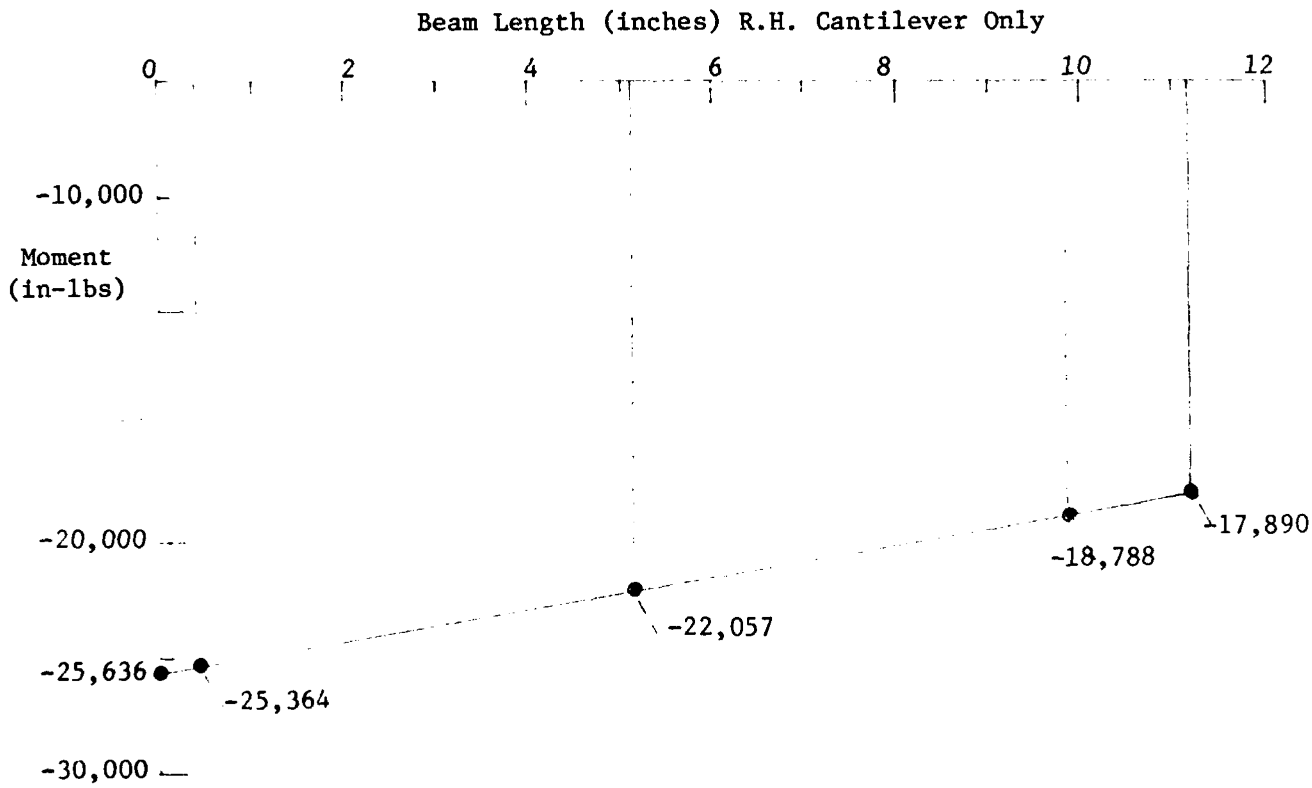




4b. Shear Diagram



4c. Moment Diagram



4d. Stresses due to bending on inner support cylinder

$$\sigma_{max} = \frac{M}{Z} = \frac{26000}{129.456} = 200.8 \text{ psi}$$

At 50 g. σ = 10040 psi

At 100g. σ = 20080 psi

4e. Shear stress on inner support cylinder

$$\tau_{max} = \frac{P}{A} = \frac{750}{14.284} = 52.50 \text{ psi shear}$$

At 50 g. τ = 2625 psi

At 100g. τ = 5250 psi

5. Weight/Moment Calculations
(All weights considered to be concentrated at the C.G.)

5a. Forward Rad Shield with forward surface of $50^{o}K$.
Support Ring used as a reference plane.

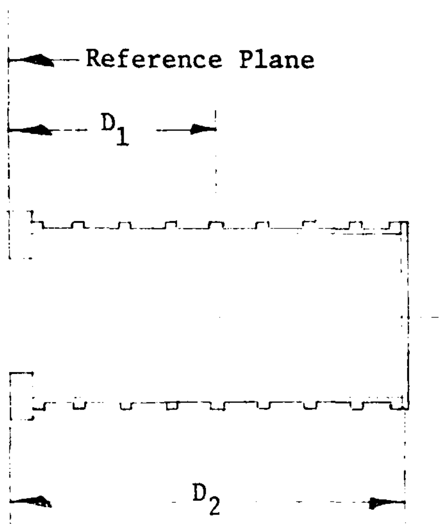
$L = 99.225$ in

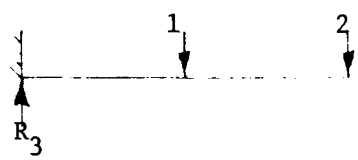
$Wt = 77.81$ lbs

Wt of Stiffeners and Flanges (9 ea) = 16.05 lbs

Total Wt = 93.86 lbs

	Item	Weight (lbs)	Distance (in)	Moment (in - lbs)
1.	Rad Shield and Stiffeners	93.86	50.362	-4727
2.	Rad Shield Cover Plate	16.30	100.035	-1631
		$R_3 =$ 110.16		$M_3 =$ -6358





5. Outer Support Cylinder ($50^{\circ}K$ to $300^{0}K$)

$$D_1 \text{ (O.D.)} = 41.688 \text{ in}$$

$$D_2 \text{ (I.D.)} = 41.438 \text{ in}$$

$$Z = \frac{\pi(D_1^{\,4} - D_2^{\,4})}{32D_1}$$

$$Z = \frac{\pi(41.688^4 - 41.438^4)}{32(41.688)}$$

$$Z = 169.088 \text{ in}^3 \quad \text{(Section Modulus)}$$

6a. Length of Outer Support Cylinder based on conductive heat loss of 1 watt

$$\lambda_{ave} = .01521 \text{ W/in-}^{\circ}K \; (50^{\circ}K \text{ to } 300^{\circ}K)$$

$$A = \pi(20.844^2 - 20.719^2) = 16.322 \text{ in}^2$$

$$L = \frac{\lambda(T_3 - T_2)\,A}{Q}$$

$$L = \frac{.01521 \;\; (300 - 50) \;\; (16.322)}{1}$$

$$L = 62.064 \text{ in}$$

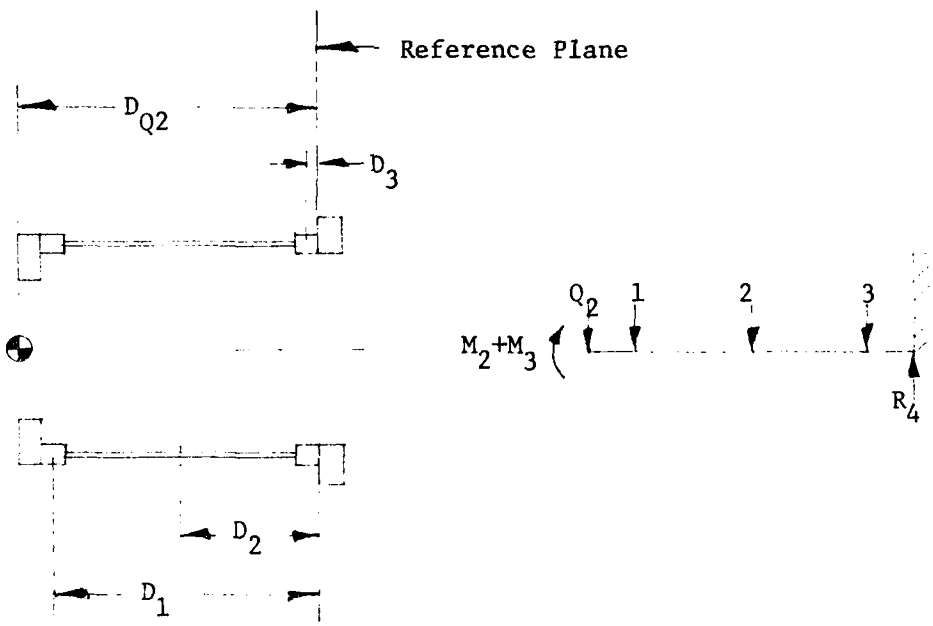
$$\text{Weight} = .0649 \text{ AL} = .0649 \; (16.322) \; (62.064)$$

$$= 65.74 \text{ lbs}$$

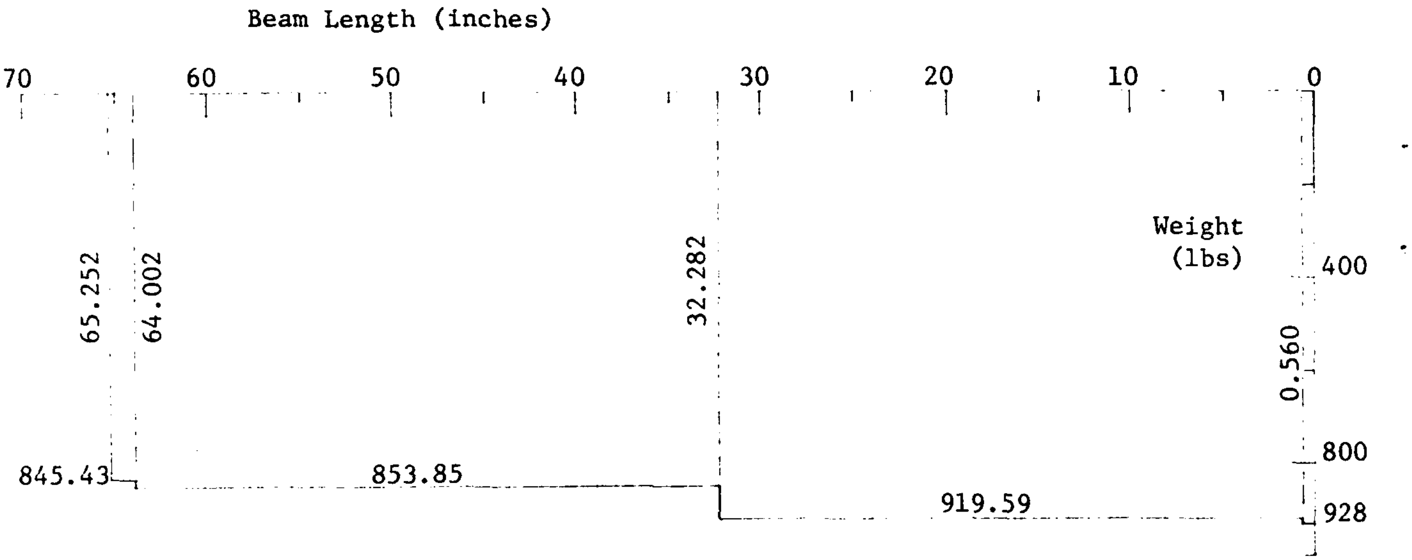
7. <u>Weight /Moment Calculations</u>
(All weights considered to be concentrated at the C.G.)

7a. Summation of all interior components with mounting surface on Center Support Ring as the reference plane.

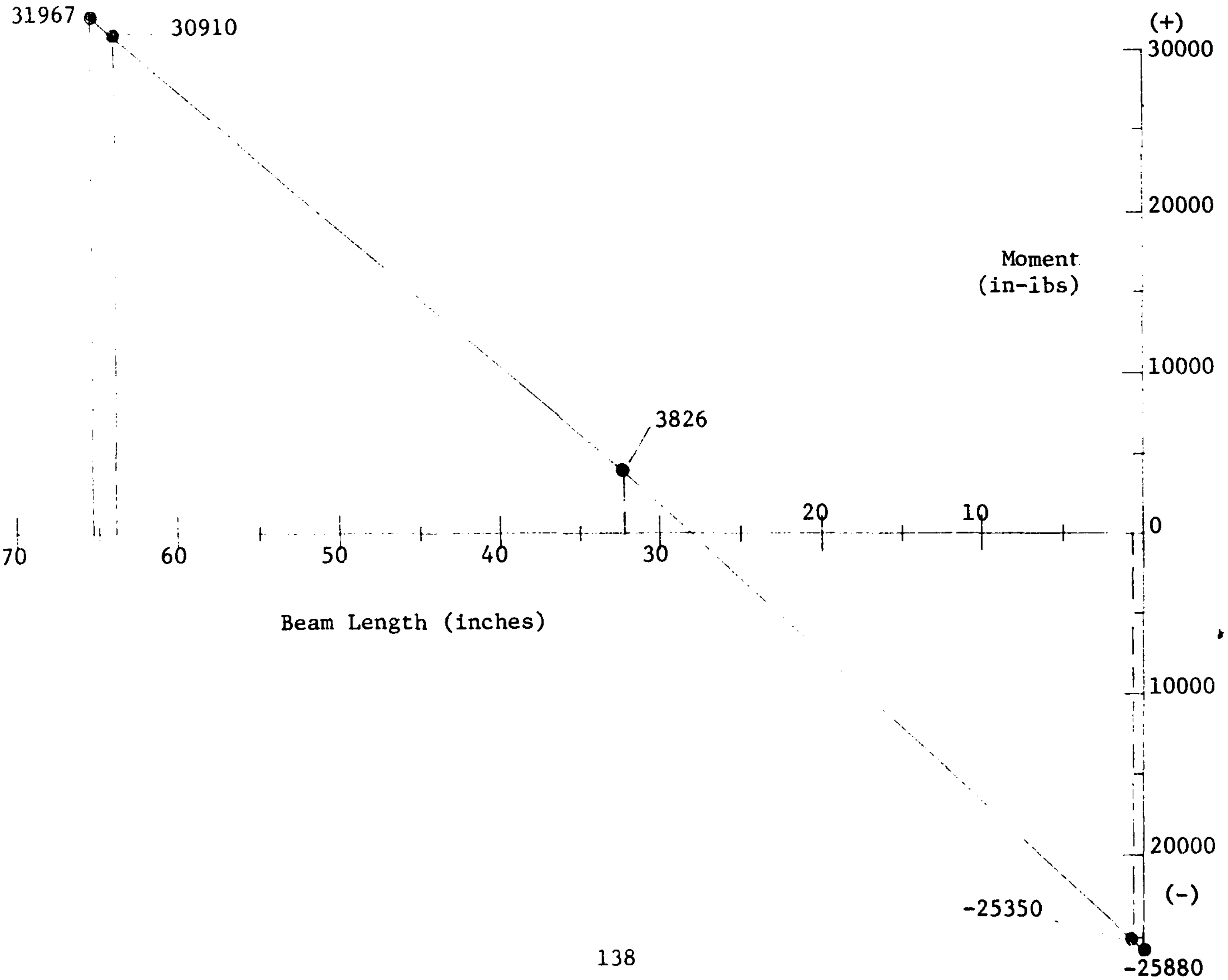
	Weight (lbs)	Distance (in)	Moment (in - lbs)
$Q_2 = R_2 + R_3$	845.43	65.272	-55183
$M_2 + M_3$			+31967
1. Support Cylinder Flange			
(50^oK)	8.41	64.002	-538
2. Outer Support Cylinder	65.74	32.282	-2122
3. Support Cylinder Flange			
(300^oF)	8.41	0.560	- 5
	R_4 = 928		M_4 = -25881



7b. Shear Diagram



7c. Moment Diagram



7d. Stress due to bending on outer support cylinder

$$\sigma_{max} = \frac{M}{Z} = \frac{31000}{169.088} = 183.3 \text{ psi}$$

At 50 g. $\sigma = 9165$ psi

At 100g. $\sigma = 18330$ psi

7e. Shear Stress on outer support cylinder

$$\tau_{max} = \frac{P}{A} = \frac{920}{16.322} = 56.4 \text{ psi}$$

At 50 g. $\tau = 2820$ psi

At 100g. $\tau = 5640$ psi

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